This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

A

PRACTICAL ARITHMETIC

ON AN ENTIRELY NEW METHOD,

FOR

SCHOOLS, COLLEGES, AND CANDIDATES
PREPARING FOR MATRICULATION, CIVIL SERVICE, EXCISE,
UNIVERSITY, LOCAL, AND OTHER EXAMINATIONS.

BY

JOHN JACKSON,
Principal, Commercial and Grammar School, Belfast.

LONDON:
BLACKIE & SON, 49 & 50 OLD BAILEY, E.C.;
GLASGOW, EDINBURGH, AND DUBLIN.
1885.

All Rights Reserved.

C
1802.f.57

BODLEIAN LIB…
18 JAN 86
OXFORD

PREFACE.

This contribution to Arithmetical Science is the outcome of several years' study and teaching of the subject.

The general plan of the book is fully explained in the Introduction. Its aim is essentially *practical*, and the endeavour has been to supply teachers with suggestions and illustrations rather than with full explanations of the various rules and methods enunciated. The author would take this opportunity to thank all who have rendered him assistance, and thereby lightened his task.

While every care has been taken to secure perfect accuracy, it is scarcely to be expected that this has been in all cases attained, and the publishers will be thankful for any notes of correction that may be sent to them.

College Green, Belfast,
1st August, 1885.

CONTENTS.

Page
List of Abbreviations, - - - - - - - - - 8
Introduction, - - - - - - - - - 9

ARITHMETICAL TABLES.

Addition, - - - - - - - - - - 15
Multiplication, - - - - - - - - - 16
Money, Weights, and Measures, - - - - - - 17
Foreign Money, - - - - - - - - - 20
Specific Gravities, - - - - - - - - 21
Perpetual Calendar, - - - - - - - - 22
Time, - - - - - - - - - - - 24
Compound Interest, - - - - - - - - 25
Squares and Cubes, - - - - - - - - 26
Prime Numbers, - - - - - - - - - 28
Aliquot Parts, - - - - - - - - - 34
Metric System, - - - - - - - - - 35
Present Value of Annuity, - - - - - - - 37
Amount of Annuity, - - - - - - - - 38
Logarithms, - - - - - - - - - 39
Signs used in Arithmetic, - - - - - - - 40
Technical Terms, - - - - - - - - 40

INTEGRAL ARITHMETIC.

Notation and Numeration, - - - - - - - 43
Roman Notation, - - - - - - - - - 46
Simple Addition, - - - - - - - - - 47
Simple Complementary Addition, - - - - - - 51
Simple Multiplication, - - - - - - - - 54
Simple Division, - - - - - - - - - 61
Contracted Multiplication, - - - - - - - 68
Proofs of Divisibility, - - - - - - - - 72

Page
Reduction, - - - - - - - - - - 74
Compound Addition, - - - - - - - - 80
Compound Complementary Addition, - - - - - - 83
Compound Multiplication, - - - - - - - 85
Compound Division, - - - - - - - - 88
Miscellaneous Questions on Preceding Rules, - - - 91
Highest Common Factor, - - - - - - - 97
Lowest Common Multiple, - - - - - - - 100

FRACTIONAL ARITHMETIC.

Vulgar Fractions, - - - - - - - - 103
Addition, &c. of Vulgar Fractions, - - - - - 109
Multiplication of Vulgar Fractions, - - - - - 112
Division of Vulgar Fractions, - - - - - - 113
Exercises on Complex Fractions, - - - - - - 115
Cross or Complex Reduction, - - - - - - 118
Reduction of Vulgar Fractions, - - - - - - 120
Decimal Fractions, - - - - - - - - 121
Addition, &c. of Decimal Fractions, - - - - - 122
Multiplication of Decimal Fractions, - - - - - 124
Division of Decimal Fractions, - - - - - - 126
Repeating Decimals, - - - - - - - - 128
Reduction of Decimals, - - - - - - - 133
Miscellaneous Questions in Decimals, - - - - - 137

COMMERCIAL ARITHMETIC.

Practice, - - - - - - - - - - 139
Simple Practice, - - - - - - - - - 139
Compound Practice, - - - - - - - - 143
Variation, - - - - - - - - - - 145
Simple Interest, - - - - - - - - - 152
Discount and Present Worth, - - - - - - 160
Chain Rule and Barter, - - - - - - - 161
Exchange, - - - - - - - - - - 164
Fellowship, - - - - - - - - - - 166
Stocks, - - - - - - - - - - 170
Profit and Loss, - - - - - - - - - 176
Equation of Payments, - - - - - - - 179

Page
Tare and Tret, - - - - - - - - - 180
Alligation, - - - - - - - - - - 182
Position, - - - - - - - - - - 184
Annuities, - - - - - - - - - - 189
Square Root, - - - - - - - - - 191
Cube Root, - - - - - - - - - - 196
Progressions, - - - - - - - - - 198
Logarithms, - - - - - - - - - - 202
Compound Interest, - - - - - - - - 206
Scales of Notation, - - - - - - - - 209
Mensuration and Duodecimal Arithmetic, - - - - 211
The Metric System, - - - - - - - - 215
Invoices and Commercial Accounts, - - - - - 217

MENTAL ARITHMETIC.

Rules and Exercises, - - - - - - - - 231

MISCELLANEOUS QUESTIONS AND EXAMINATION PAPERS.

Oxford and Cambridge Local, - - - - - - 249
Intermediate Arithmetic, set at various Examinations, - - 262
Advanced, set at Civil Service and other Examinations, - 281
Matriculation Examination Papers, Belfast, - - - - 310
Intermediate Education (Ireland) Examination Papers (1879–1885), - - - - - - - - 312

APPENDIX, - - - - - - - - - - 329

ANSWERS, - - - - - - - - - - 334

PRINCIPAL ABBREVIATIONS, &c. USED IN BUSINESS.

@ = At.
a/c
Acc't. = Account.
Amt. = Amount.
Ass'd. = Assorted.
Av. = Average.
Bal.
B/ce = Balance.
Bot. = Bought.
B. L. = Bill of Lading.
c/o = Care of.
Co. = Company.
Cr. = Credit or Creditor.
Com.
Comm. = Commission.
Const. = Consignment.
d/a = Days after acceptance.
d/d = Days after date.
Dft. = Draft.
Disct. = Discount.
Do. = The same.
Doz. = Dozen.
Dr. = Debtor or Debit.
Ea. = Each.
Exch. = Exchange.
Exps. = Expenses.
E. & O.E. = Errors and Omissions Excepted.
Fo.
Fol. = Folio.
For.
Fwd. = Forward.
Frt. = Freight.
Gal. = Gallon.
Hhds. = Hogsheads.
Ins. = Insurance.
Inst. = This month.
Int. = Interest.
Invt. = Inventory.
m/s = Months after sight.
m/d = Months after date.
Mdse. = Merchandise.
Mo. = Month.
Net = Without discount or further reduction.
No. = Number.
°/o = Per cent.
Payt. = Payment.
Pd. = Paid.
Per = By.
Prem. = Premium.
Prox. = Next month.
Ps. = Pieces.
Recd. = Received.
Shipt. = Shipment.
S.S. = Steamship.
Ult. = Last month.
Whf. = Wharf.
Yd. = Yard.
Yr. = Year.

PRACTICAL ARITHMETIC.

INTRODUCTION.

It is confidently hoped that the following pages will afford to the teacher and scholar alike such a course of arithmetical study as shall reduce to a minimum the labour of both, and invest the subject with an interest worthy of its importance. The author has endeavoured to produce a treatise which shall supply easy and short rules, simple and brief methods, terse and comprehensive explanations, numerous and appropriate examples. The Rules, he believes, are the easiest and shortest that can be given; the methods are in many cases new and in all cases practical; the explanations are as few as possible, only requiring black-board illustration to render them intelligible to every ordinary class; whilst the exercises given exceed in number those to be found in any similar text-book. One peculiar feature of the work is to be found in the adoption of the fractional form for the solution of questions in nearly all the advanced rules. By the application of this method and the principle of cancelling, labour is minimized, and the possibility of making mistakes wonderfully lessened. Another important feature consists in the exclusion of the rule of "Subtraction," as ordinarily given, and the substitution of the easy and graceful rule of Incremental or Complementary Addition, an innovation which, in the humble opinion of the author, is of itself calculated to effect a revolution in the science of arithmetic, and the value of the rule increases with every advance in the subject. Inasmuch as "*the First Four Rules*," now for the first time reduced practically to "*Three*," constitute all arithmetic, no apology is needed for devoting so much attention to them and providing such a large number of exercises. In this department also is given a most valuable selection of general and special contractions, the astonishing utility of which can only be appreciated in the practical calculations of the higher rules. With regard to the abbreviated methods with which this treatise abounds it may be stated there is no part of arithmetic so fascinating to the scholar. Most teachers will find the rules eagerly and easily apprehended by their classes, and more work is generally got through at a single lesson in Contractions than in three or four at the ordinary methods.

The section giving tables of Weights and Measures, and various other useful Tables, will be found unusually rich and complete. It may be claimed for this Arithmetic that it is an entirely unique production, and that in no treatise extant are the same excellencies attempted or even suggested. To the commercial student, to the professional man, to the merchant, to the civil service or university candidate, and to master and pupil, the work will prove alike invaluable.

The distinguishing features of this Arithmetic may be summarized as follows:—

a. Negative.

1. The absence of tedious and prolix operations.
2. The absence of the rules of Subtraction and Proportion.
3. The absence of all unnecessary theory and of all Proofs of Accuracy.

b. Positive.

1. Copious sets of examples, carefully selected from Examination Papers.
2. The adoption of a new and easy rule to supersede the rule of "Subtraction."
3. The adoption of a much shorter, simpler, and easier method of working "Long Division."
4. The employment of a much easier rule to supersede the rule of "Proportion."
5. The employment of a large number of short methods both general and particular in nearly every section *of arithmetic.*

6. The introduction of the "Fractional Form" in all Intermediate and Advanced Rules, whereby labour is reduced to a minimum.
7. The introduction of an extensive collection of valuable Tables of Interest, Powers, Primes, Logarithms, &c. &c.
8. Careful adaptation to Competitive and Mercantile requirements.

EXAMPLES

SHOWING THE SUPERIORITY OF THE SHORTER METHODS OF WORKING, AS TAUGHT IN THIS WORK, TO THE ORDINARY METHODS.

In a recently published work by a justly celebrated arithmetician the following question in Practice is given, with the remark that Practice affords no shorter method than the tedious and clumsy working herein marked (1). As an experiment the question was given to a class for solution on the "short style," and it was quickly worked correctly by several pupils exactly as found in Example marked (2).

Find the value of 269 articles at 15*s.* 8¼*d.* each.

(1)

		269 @ 15*s.* 8¼*d.*		
10*s.*	$\frac{1}{2}$	134	10	0
5*s.*	$\frac{1}{2}$	67	5	0
6*d.*	$\frac{1}{10}$	6	14	6
2*d.*	$\frac{1}{3}$	2	4	10
¼*d.*	$\frac{1}{8}$	0	5	7¼
		£210	19	11¼

(2)

4*s.*	$\frac{1}{5}$	269 @ £1 ~ (4*s.* 3¾*d.*).		
3*d.*	$\frac{1}{16}$	53	16	
¾*d.*	$\frac{1}{4}$	3	7	3
			16	9¾
		£210	19	11¼

By complementary addition.

The sum just furnished offers a fair specimen of the time and labour saved in the Rule of Practice. In order to exhibit, however, more fully the immense advantages accruing from a familiarity with and expertness in the Contracted Methods, some questions actually given in public examinations will be herein worked by both systems. It will not be necessary to indicate which are the "*old*" and which the "*new*."

SPECIMEN PAPER.

1. Find the L. C. M. of 18, 16, 36, 44, 45, 48, 63, 121.
2. Find the H. C. F. (or G. C. M.) of 40457 and 420325.
3. Find the square root of 25816561.
4. Goods were bought for £560, 15*s.* 6*d.*; extra charges were packing, £1, 10*s.*; carriage, £12, 6*s.* 8½*d.*; duty, £3, 8*s.* 6¾*d.* If the goods were sold for £655, 8*s.* 5*d.* what was gained on the transaction?
5. Find Simple Interest on £1585, 17*s.* 6*d.* for 6⅔ years @ 4½ per cent.

SOLUTIONS.

No. 1.

$$\begin{array}{r|cccccccccccccccc}
2 & 18 & . & 16 & . & 36 & . & 44 & . & 45 & . & 48 & . & 63 & . & 121 \\ \hline
2 & 9 & . & 8 & . & 18 & . & 22 & . & 45 & . & 24 & . & 63 & . & 121 \\ \hline
2 & 9 & . & 4 & . & 9 & . & 11 & . & 45 & . & 12 & . & 63 & . & 121 \\ \hline
2 & 9 & . & 2 & . & 9 & . & 11 & . & 45 & . & 6 & . & 63 & . & 121 \\ \hline
3 & 9 & . & 1 & . & 9 & . & 11 & . & 45 & . & 3 & . & 63 & . & 121 \\ \hline
3 & 3 & . & 1 & . & 3 & . & 11 & . & 15 & . & 1 & . & 21 & . & 121 \\ \hline
11 & 1 & . & 1 & . & 1 & . & 11 & . & 5 & . & 1 & . & 7 & . & 121 \\ \hline
 & 1 & . & 1 & . & 1 & . & 1 & . & 5 & . & 1 & . & 7 & . & 11 \\ \hline\hline
\end{array}$$

$\therefore$ L. C. M. $= 2 \times 2 \times 2 \times 2 \times 3 \times 3 \times 11 \times 11 \times 7 \times 5 = 609840$. Ans.

(107 figures, exclusive of lines, dots, &c.)

$$\begin{array}{r|cccccccccccccccc}
5 . 7 . 8 . 9 & \cancel{1}\cancel{8} & . & \cancel{1}\cancel{6} & . & \cancel{3}\cancel{6} & . & \cancel{4}\cancel{4} & . & \cancel{4}\cancel{5} & . & 48 & . & \cancel{6}\cancel{3} & . & 121 \\ \hline
 & & & & & & & & & & & 2 & & & & 121 \\ \hline\hline
\end{array}$$

$\therefore$ L. C. M. $= 5 \times 7 \times 8 \times 9 \times 121 \times 2 = 609840$. Ans.

(16 figures, exclusive of lines, dots, &c.)

No. 2.

```
40457) 420325 (10
       404570
       ------
        15755) 40457 (2
               31510
               -----
                8947) 15755 (1
                       8947
                      -----
                      6808) 8947 (1
                            6808
                            ----
                            2139) 6808 (3
                                  6417
                                  ----
                                   391) 2139 (5
                                        1955
                                        ----
                                         184) 391 (2
                                              368
                                              ---
                                               23) 184 (8
                                                   184
                                                   ---
```

(95 figures, exclusive of lines.)

```
40457 | 420325
------|-------
 8947 |  15755
------|-------
 2139 |   6808
------|-------
  184 |    391
------|-------
      |     23
```

(25 figures, exclusive of lines.)

No. 3.

```
        25′81′65′61 (5081
        25
     ----------
1008   |  8165
       |  8064
     ------------
 10161 |  10161
       |  10161
     ------------
```

(29 figures, exclusive of lines, &c.)

```
      25′81′65′61 (5081
 ------------
 1008  | 8165
 -------------
 10161 | 10161
 -------------
```

(18 figures, exclusive of lines, &c.)

No. 4.

£	s.	d.
560	15	6
1	10	0
12	6	8½
3	8	6¾
578	0	9¼

£	s.	d.	
655	8	5	
578	0	9¼	
77	7	7¾	Ans.

£	s.	d.	
655	8	5	
560	15	6	
1	10	0	
12	6	8½	
3	8	6¾	
77	7	7¾	Ans.

(1 instead of 2 operations, and 14 figures saved).

No. 5.

	£	s.	d.
	1585	17	6
			6
	9515	5	0
	1057	5	0
2)	10572	10	0
			4½
	42290	0	0
	5286	5	0
	475,76	5	0
	20		
	15,25		
	12		
	3,00		

∴ Ans. is £475, 15*s.* 3*d.*

	£	s.	d.	
	1585	17	6	
			2	
3)	3171	15	0	
	1057	5	0	= ⅔

$$\frac{\overset{\pounds\quad s.\quad d.}{1585\ \ 17\ \ 6} \times 6\frac{2}{3} \times 4\frac{1}{2}}{100} = \frac{\overset{\overset{\pounds\quad s.\quad d.}{158\ \ 11\ \ 9}}{\cancel{1585}\ \ \cancel{17}\ \ \cancel{6}} \times \cancel{20} \times \cancel{9}}{\underset{5}{\cancel{100}} \times \underset{2}{\cancel{6}}} = \overset{\text{Ans.}}{\pounds 475,\ 15s.\ 3d.}$$

(The superiority here is too obvious to require comment.)

ARITHMETICAL TABLES.

It is not intended that all the tables, &c., in this section should be committed to memory. The teacher will exercise his own judgment as to which shall be first learned and how many are to be mastered; but the author would suggest that they be taken up in the order of their occurrence in the text, or as they would be required in studying the subject. Such tables as the Primes, Annuities, &c., are intended only for reference, all the others should be perfectly mastered. Sometimes the system is adopted, and with the happiest results, of giving one, or a part of one, table each evening as a home lesson to be written out and learned. Where this plan obtains the pupils have seldom if ever to refer to the section on tables during their arithmetical work.

I. TABLES OF ADDITION.

(Units.)

$1+1=2$
$1+2=3$
$1+3=4$
$1+4=5$
$1+5=6$
$1+6=7$
$1+7=8$
$1+8=9$
$1+9=1\underline{0}$

$2+2=4$
$2+3=5$
$2+4=6$
$2+5=7$
$2+6=8$
$2+7=9$
$2+8=1\underline{0}$
$2+9=1\underline{1}$

$3+3=6$
$3+4=7$
$3+5=8$
$3+6=9$
$3+7=1\underline{0}$
$3+8=1\underline{1}$
$3+9=1\underline{2}$

$4+4=8$
$4+5=9$
$4+6=1\underline{0}$
$4+7=1\underline{1}$
$4+8=1\underline{2}$
$4+9=1\underline{3}$

$5+5=1\underline{0}$
$5+6=1\underline{1}$
$5+7=1\underline{2}$
$5+8=1\underline{3}$
$5+9=1\underline{4}$

$6+6=1\underline{2}$
$6+7=1\underline{3}$
$6+8=1\underline{4}$
$6+9=1\underline{5}$

$7+7=1\underline{4}$
$7+8=1\underline{5}$
$7+9=1\underline{6}$

$8+8=1\underline{6}$
$8+9=1\underline{7}$

$9+9=1\underline{8}$

(Tens.)

$1+9=\underline{10}=9+1$
$2+8=\underline{10}=8+2$
$3+7=\underline{10}=7+3$
$4+6=\underline{10}=6+4$
$5+5=\underline{10}=5+5$

$2+9+9=\underline{20}=4+8+8$
$3+8+9=\underline{20}=5+7+8$
$4+7+9=\underline{20}=6+6+8$
$5+6+9=\underline{20}=6+7+7$

II. TABLE OF MULTIPLICATION.

1	2	3	4	5	6	7	8	9	10
2	4	6	8	10	12	14	16	18	20
3	6	9	12	15	18	21	24	27	30
4	8	12	16	20	24	28	32	36	40
5	10	15	20	25	30	35	40	45	50
6	12	18	24	30	36	42	48	54	60
7	14	21	28	35	42	49	56	63	70
8	16	24	32	40	48	56	64	72	80
9	18	27	36	45	54	63	72	81	90
10	20	30	40	50	60	70	80	90	100
11	22	33	44	55	66	77	88	99	110
12	24	36	48	60	72	84	96	108	120
13	26	39	52	65	78	91	104	117	130
14	28	42	56	70	84	98	112	126	140
15	30	45	60	75	90	105	120	135	150
16	32	48	64	80	96	112	128	144	160
17	34	51	68	85	102	119	136	153	170
18	36	54	72	90	108	126	144	162	180
19	38	57	76	95	114	133	152	171	190
20	40	60	80	100	120	140	160	180	200

11	12	13	14	15	16	17	18	19	20
22	24	26	28	30	32	34	36	38	40
33	36	39	42	45	48	51	54	57	60
44	48	52	56	60	64	68	72	76	80
55	60	65	70	75	80	85	90	95	100
66	72	78	84	90	96	102	108	114	120
77	84	91	98	105	112	119	126	133	140
88	96	104	112	120	128	136	144	152	160
99	108	117	126	135	144	153	162	171	180
110	120	130	140	150	160	170	180	190	200
121	132	143	154	165	176	187	198	209	220
132	144	156	168	180	192	204	216	228	240
143	156	169	182	195	208	221	234	247	260
154	168	182	196	210	224	238	252	266	280
165	180	195	210	225	240	255	270	285	300
176	192	208	224	240	256	272	288	304	320
187	204	221	238	255	272	289	306	323	340
198	216	234	252	270	288	306	324	342	360
209	228	247	266	285	304	323	342	361	380
220	240	260	280	300	320	340	360	380	400

III. TABLES OF MONEY, WEIGHTS, AND MEASURES.

4 farthings = 1 penny.
12 pence = 1 shilling.
20 shillings = 1 pound.

The standard of gold coins is 22 parts of pure gold and 2 parts copper. 1 lb. of standard gold is worth £46, 14*s*. 6*d*.

The standard of silver coin is 37 parts pure silver to 3 parts alloy. 1 lb. of standard silver is worth £3, 6*s*. 0*d*.

OBSOLETE COINS.

21 shillings = 1 guinea.
23 ,, = 1 carolus.
25 ,, = 1 jacobus.
27 ,, = 1 moidore.
6*s*. 8*d*. = 1 noble.
10*s*. 0*d*. = 1 angel.
13*s*. 4*d*. = 1 mark.
16*s*. 10*d*. = 1 pistole.

PENCE.

		s.	*d*.
12 pence	=	1	0
20 ,,	=	1	8
24 ,,	=	2	0
30 ,,	=	2	6
36 ,,	=	3	0
40 ,,	=	3	4
48 ,,	=	4	0
50 ,,	=	4	2
60 ,,	=	5	0
70 ,,	=	5	10
72 ,,	=	6	0
80 ,,	=	6	8
84 ,,	=	7	0
90 ,,	=	7	6
96 ,,	=	8	0
100 ,,	=	8	4
108 ,,	=	9	0
110 pence	=	9	2
120 ,,	=	10	0
130 ,,	=	10	10
132 ,,	=	11	0
140 ,,	=	11	8
144 ,,	=	12	0
150 ,,	=	12	6
156 ,,	=	13	0
160 ,,	=	13	4
168 ,,	=	14	0
170 ,,	=	14	2
180 ,,	=	15	0
190 ,,	=	15	10
192 ,,	=	16	0
200 ,,	=	16	8

SHILLINGS.

		£	*s*.	*d*.
20 shillings	=	1	0	0
30 ,,	=	1	10	0
40 ,,	=	2	0	0
50 ,,	=	2	10	0
60 ,,	=	3	0	0
70 ,,	=	3	10	0
80 ,,	=	4	0	0
90 ,,	=	4	10	0
100 ,,	=	5	0	0
110 ,,	=	5	10	0
120 ,,	=	6	0	0
130 ,,	=	6	10	0
140 ,,	=	7	0	0
150 ,,	=	7	10	0
160 ,,	=	8	0	0
170 ,,	=	8	10	0
180 ,,	=	9	0	0
190 ,,	=	9	10	0
200 ,,	=	10	0	0
300 ,,	=	15	0	0
500 ,,	=	25	0	0
1000 ,,	=	50	0	0

TROY WEIGHT

(used in weighing gold and silver, &c.).

4 grs. = 1 carat.
24 grains = 1 pennyweight.
20 dwts. = 1 ounce (oz.).
12 oz. = 1 pound (lb.).
5760 grains = 1 lb

APOTHECARIES' WEIGHT

(used in compounding medicines).

20 grains = 1 scruple (℈).
3 scr. = 1 dram (ʒ).
8 dr. = 1 ounce (℥).
12 oz. = 1 ℔.

APOTHECARIES' MEASURE.

1 fluid minim (♏) = ·0045 cub. in.
60 ,, ,, = 1 fl. dr. (ʒ).
8 drs. = 1 fl. oz. (℥).
20 oz. = 1 pint (O).

AVOIRDUPOIS WEIGHT

(for groceries, drugs, and heavy goods).

16 drams = 1 ounce.
16 oz. = 1 lb.
14 lbs. = 1 stone.
2 st. or 28 lbs. = 1 quarter.
4 qr. or 112 lbs. = 1 hundredweight.
20 cwts. or 2240 lbs. = 1 ton.
7000 Troy grains = 1 lb. (avoir.).

WOOL WEIGHT.

7 lbs. = 1 clove.
2 cl. = 1 stone.
2 st. = 1 tod.
6½ tods = 1 wey.
2 weys = 1 sack.
12 sacks = 1 last.
240 lbs. = 1 pack.

LONG MEASURE.

12 lines = 1 inch.
12 in. = 1 foot.
3 ft. = 1 yard.
6 feet = 1 fathom.
5½ yds. = 1 rod or pole.
40 po. = 1 furlong.
8 fur. = 1 mile.
3 mi. = 1 league.

SQUARE MEASURE.

144 square inches = 1 sq. foot
9 ,, feet = 1 ,, yar
30¼ ,, yards = 1 ,, pole
40 ,, poles = 1 rood.
4 roods = 1 acre.
640 acres = 1 sq. mil

SURVEYORS' MEASURE.

7·92 inches = 1 link.
100 links = 1 chain
80 chains = 1 mile.
100,000 sq. links or 10 ,, chains = 1 acre.

CUBIC MEASURE.

1728 cub. inches = 1 cub. foo
27 ,, feet = 1 ,, yar
40 ,, ,, = 1 load of rou timber.
50 ,, ,, = 1 load of squar timber.
42 ,, ,, = 1 ton of shippin

DRY MEASURE.

4 gills = 1 pint.
2 pts. = 1 quart.
4 qts. = 1 gallon.
2 gals. = 1 peck.
4 pecks = 1 bushel.
8 bush. = 1 quarter.
5 qrs. = 1 load.
2 loads = 1 last.

ALE AND BEER MEASURE.

2 pints = 1 quart.
4 qts. = 1 gallon.
9 gals. = 1 firkin.
2 firk. = 1 kilderkin.
2 kil. = 1 barrel.
1½ bar. = 1 hogshead.
2 hogs. = 1 butt.
2 butts = 1 tun.

WINE MEASURE.

4 gills = 1 pint.
2 pints = 1 quart.
4 qts. = 1 gallon.
10 gals. = 1 anker.
18 ,, = 1 runlet.
42 ,, = 1 tierce.
84 ,, = 1 puncheon.
63 ,, = 1 hogshead.
2 hogs. = 1 pipe.
2 pipes = 1 tun.

LINEN YARN.

300 yards = 1 cut.
2 cuts = 1 heer.
6 heers = 1 hasp.
4 hasps = 1 spindle.

COTTON YARN.

120 yards = 1 skein.
7 skeins = 1 hank.
18 hanks = 1 spindle.

MISCELLANEOUS.

56 lbs. = 1 firkin of butter.
112 ,, = 1 quintal of fish.
280 ,, = 1 sack of flour.
4 pecks = 1 bushel of coal.
3 bushels = 1 sack ,,
36 ,, = 1 chaldron ,,
24 sheets = 1 quire of paper.
20 quires = 1 ream ,,
10 reams = 1 bale ,,
3 inches = 1 palm.
4 ,, = 1 hand.
9 ,, = 1 span.
18 ,, = 1 cubit.
5 feet = 1 pace.
272¼ sq. ft. = 1 rod of brickwork.
100 ,, = 1 square of flooring.
30 acres = 1 yard of land.
100 ,, = 1 hide of land.
2000 yards = 1 knot (naut. mile).
2240 ,, = 1 Irish mile.
4840 sq. yds. = 1 English acre.
6250 ,, = 1 Scotch ,,
7840 ,, = 1 Irish ,,
12 articles = 1 dozen.
20 ,, = 1 score.
5 score = 1 hundred.
6 ,, = 1 long hundred.
12 dozen = 1 gross.
108 gallons = 1 butt of sherry.
19½ cwt. = 1 fodder of lead.
24 oz. = 1 great pound of silk.

TIME MEASURE.

60 seconds = 1 minute.
60 min. = 1 hour.
24 hrs. = 1 day.
7 days = 1 week.
4 weeks = 1 month.
13 Lunar mos. = 1 year.
12 Calendar mos. = 1 year.
365 days = 1 com. year.
366 ,, = 1 leap year.
365¼ ,, = 1 Julian year.
365 d. 5 h. 48 m. 48 sec. } = 1 Solar year.
100 years = 1 century.

CIRCULAR MEASURE.

60 thirds (‴) = 1 second (″).
60 seconds = 1 minute (′).
60 minutes = 1 degree (°).
90 degrees = 1 quadrant.
360 ,, = 1 circle.

TERM DAYS

(England and Ireland).

Lady Day is on 25th March.
Midsummer Day ,, 24th June.
Michaelmas Day ,, 29th Sept.
Christmas Day ,, 25th Dec.

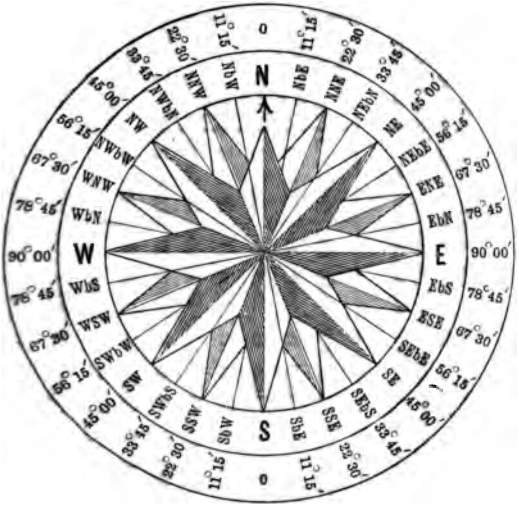
IV. TABLE OF FOREIGN MONEY.

COUNTRY.	COIN.	VALUE.		
		£	s.	d.
Argentine Republic,	Dollar,	0	4	0
Austria-Hungary,	Florin,	0	1	11¾
Belgium,	Franc,	0	0	9½
Bolivia,	Peso or Dollar,	0	3	4
Brazil,	Milrea,	0	2	3
Chili,	Peso or Dollar,	0	3	4
,,	Doubloon,	0	18	9
China,	Tael,	0	5	10
Cuba,	Dollar,	0	4	2
Denmark,	Krone or Crown,	0	1	1⅛
France,	Franc,	0	0	9½
,,	Napoleon,	0	15	10¼
Germany (including Prussia and all the other States),	Mark,	0	1	0
,,	Thaler,	0	3	0
Greece,	Drachma,	0	0	8¾
Holland,	Florin,	0	1	8
India,	Rupee,	0	2	0
Italy,	Lira,	0	0	9½
Japan,	Yen or Dollar,	0	3	8
Mexico,	Dollar,	0	3	8
,,	Doubloon,	3	4	8
Norway,	Krone or Crown,	0	1	1½
Persia,	Toman,	0	9	3½
Peru,	Dollar,	0	3	4
Portugal,	Milrea,	0	4	5
Prussia (see Germany).				
Russia,	Rouble,	0	3	2
Servia,	Dinar,	0	0	9½
Siam,	Tical or Bat,	0	2	2¼
Spain,	Peseta,	0	0	9½
,,	Escudo,	0	2	0
,,	Doubloon,	1	0	7½
Sweden,	Crown,	0	1	1½
,,	Ducat (Gold),	0	9	2¼
Switzerland,	Franc,	0	0	9½
Turkey,	Piastre,	0	0	2½
,,	Sequin,	0	9	3
United States,	Dollar,	0	4	1½
,, ,,	Eagle (10 Dollars),	2	1	1
Uruguay,	Peso or Dollar,	0	4	3

V. SPECIFIC GRAVITY OF BODIES.

MATERIAL.	S.G.	MATERIAL.	S.G.	MATERIAL.	S.G.
Platinum, .	22,075	Flint, . .	2570	Sulphuric Acid, .	1840
Gold, . .	19,365	Glass, . .	2480	Milk, ...	1030
Mercury, .	13,600	Bromine, .	2960	Claret, ...	990
Lead, . .	11,350	Clay, . .	2160	Olive Oil, . . .	910
Silver, . .	10,475	Light Earth,	1984	Oil of Turpentine,	870
Copper,. .	8,875	Ivory, . .	1825	Absolute Alcohol,	800
Gun-metal,	8,784	Anthracite,	1800	Ether, ...	720
Cast Brass,	8,000	Chalk, . .	1793	Cork, ...	240
Steel, . .	7,850	Sand, . .	1520		
Iron, . .	7,780	Ebony, . .	1331		
Tin, . . .	7,320	Coal, . .	1320		
Zinc, . .	6,860	Pitch, . .	1150		
Diamonds,.	3,530	Amber, . .	1070		
Granite, .	3,000	Mahogany,	1063		
Marble, .	2,830	Boxwood, .	1030		
Aluminium,	2,680	Sea-water,.	1030	Pure Water, . .	1000

VI. THE MARINER'S COMPASS.



VII. PERPETUAL CALENDAR.

To find the day of the week corresponding (say) to the 15th September, 1871. Find the letter of the year 1871. It is A. Then opposite September in the months find A, and below it is the calendar of September for 1871, showing the 15th to be Friday. In leap year use first letter for January and February, and the second letter for the other months.

1800 E	1828 F E	1856 F E	1884 F E	
1801 D	1829 D	1857 D	1885 D	
1802 C	1830 C	1858 C	1886 C	
1803 B	1831 B	1859 B	1887 B	
1804 A G	1832 A G	1860 A G	1888 A G	
1805 F	1833 F	1861 F	1889 F	
1806 E	1834 E	1862 E	1890 E	
1807 D	1835 D	1863 D	1891 D	
1808 C B	1836 C B	1864 C B	1892 C B	1912 F E
1809 A	1837 A	1865 A	1893 A	1913 D
1810 G	1838 G	1866 G	1894 G	1914 C
(1)	(2)	(3)	(4)	(5)

Months.							
January, .	A	B	C	D	E	F	G
February, .	D	E	F	G	A	B	C
March, . .	D	E	F	G	A	B	C
April, . .	G	A	B	C	D	E	F
May, . .	B	C	D	E	F	G	A
June, . .	E	F	G	A	B	C	D
July, . .	G	A	B	C	D	E	F
August, .	C	D	E	F	G	A	B
September,	F	G	A	B	C	D	E
October, .	A	B	C	D	E	F	G
November,	D	E	F	G	A	B	C
December,	F	G	A	B	C	D	E
	1 S.	1 Sa.	1 Fr.	1 Th.	1 W.	1 Tu.	1 M.
	2 M.	2 S.	2 Sa.	2 Fr.	2 Th.	2 W.	2 Tu.
	3 Tu.	3 M.	3 S.	3 Sa.	3 Fr.	3 Th.	3 W.
	4 W.	4 Tu.	4 M.	4 S.	4 Sa.	4 Fr.	4 Th.
	5 Th.	5 W.	5 Tu.	5 M.	5 S.	5 Sa.	5 Fr.
	(6)	(7)	(8)	(9)	(10)	(11)	(12)

(1)		(2)		(3)		(4)		(5)	
1811	F	1839	F	1867	F	1895	F	1915	B
1812	E D	1840	E D	1868	E D	1896	E D	1916	A G
1813	C	1841	C	1869	C	1897	C	1917	F
1814	B	1842	B	1870	B	1898	B	1918	E
1815	A	1843	A	1871	A	1899	A	1919	D
1816	G F	1844	G F	1872	G F	1900	G F	1920	C B
1817	E	1845	E	1873	E	1901	E	1921	A
1818	D	1846	D	1874	D	1902	D	1922	G
1819	C	1847	C	1875	C	1903	C	1923	F
1820	B A	1848	B A	1876	B A	1904	B A	1924	E D
1821	G	1849	G	1877	G	1905	G	1925	C
1822	F	1850	F	1878	F	1906	F		
1823	E	1851	E	1879	E	1907	E		
1824	D C	1852	D C	1880	D C	1908	D C		
1825	B	1853	B	1881	B	1909	B		
1826	A	1854	A	1882	A	1910	A		
1827	G	1855	G	1883	G	1911	G		

(6)		(7)		(8)		(9)		(10)		(11)		(12)	
6	Fr.	6	Th.	6	W.	6	Tu.	6	M.	6	**S.**	6	Sa.
7	Sa.	7	Fr.	7	Th.	7	W.	7	Tu.	7	M.	7	**S.**
8	**S.**	8	Sa.	8	Fr.	8	Th.	8	W.	8	Tu.	8	M.
9	M.	9	**S.**	9	Sa.	9	Fr.	9	Th.	9	W.	9	Tu.
10	Tu.	10	M.	10	**S.**	10	Sa.	10	Fr.	10	Th.	10	W.
11	W.	11	Tu.	11	M.	11	**S.**	11	Sa.	11	Fr.	11	Th.
12	Th.	12	W.	12	Tu.	12	M.	12	**S.**	12	Sa.	12	Fr.
13	Fr.	13	Th.	13	W.	13	Tu.	13	M.	13	**S.**	13	Sa.
14	Sa.	14	Fr.	14	Th.	14	W.	14	Tu.	14	M.	14	**S.**
15	**S.**	15	Sa.	15	Fr.	15	Th.	15	W.	15	Tu.	15	M.
16	M.	16	**S.**	16	Sa.	16	Fr.	16	Th.	16	W.	16	Tu.
17	Tu.	17	M.	17	**S.**	17	Sa.	17	Fr.	17	Th.	17	W.
18	W.	18	Tu.	18	M.	18	**S.**	18	Sa.	18	Fr.	18	Th.
19	Th.	19	W.	19	Tu.	19	M.	19	**S.**	19	Sa.	19	Fr.
20	Fr.	20	Th.	20	W.	20	Tu.	20	M.	20	**S.**	20	Sa.
21	Sa.	21	Fr.	21	Th.	21	W.	21	Tu.	21	M.	21	**S.**
22	**S.**	22	Sa.	22	Fr.	22	Th.	22	W.	22	Tu.	22	M.
23	M.	23	**S.**	23	Sa.	23	Fr.	23	Th.	23	W.	23	Tu.
24	Tu.	24	M.	24	**S.**	24	Sa.	24	Fr.	24	Th.	24	W.
25	W.	25	Tu.	25	M.	25	**S.**	25	Sa.	25	Fr.	25	Th.
26	Th.	26	W.	26	Tu.	26	M.	26	**S.**	26	Sa.	26	Fr.
27	Fr.	27	Th.	27	W.	27	Tu.	27	M.	27	**S.**	27	Sa.
28	Sa.	28	Fr.	28	Th.	28	W.	28	Tu.	28	M.	28	**S.**
29	**S.**	29	Sa.	29	Fr.	29	Th.	29	W.	29	Tu.	29	M.
30	M.	30	**S.**	30	Sa.	30	Fr.	30	Th.	30	W.	30	Tu.
31	Tu.	31	M.	31	**S.**	31	Sa.	31	Fr.	31	Th.	31	W.

VIII. TIME TABLE

Showing the number of days from any day in one month to the same day in any other month.

FROM ANY DAY IN	TO THE SAME DAY IN											
	Mo. 1	Mo. 2	Mo. 3	Mo 4	Mo. 5	Mo. 6	Mo. 7	Mo. 8	Mo. 9	Mo. 10	Mo. 11	Mo. 12
Jan. to	Feb. 31	Mar. 59	Apr. 90	May 120	Jne. 151	July 181	Aug. 212	Sep. 243	Oct. 273	Nov. 304	Dec. 334	Jan. 365
Feb. to	Mar. 28	Apr. 59	May 89	Jne. 120	July 150	Aug. 181	Sep. 212	Oct. 242	Nov. 273	Dec. 303	Jan. 334	Feb. 365
Mar. to	Apr. 31	May 61	Jne. 92	July 122	Aug. 153	Sep. 184	Oct. 214	Nov. 245	Dec. 275	Jan. 306	Feb. 337	Mar. 365
Apr. to	May 30	Jne. 61	July 91	Aug. 122	Sep. 153	Oct. 183	Nov. 214	Dec. 244	Jan. 275	Feb. 306	Mar. 334	Apr. 365
May to	Jne. 31	July 61	Aug. 92	Sep. 123	Oct. 153	Nov. 184	Dec. 214	Jan. 245	Feb. 276	Mar. 304	Apr. 335	May 365
Jne. to	July 30	Aug. 61	Sep. 92	Oct. 122	Nov. 153	Dec. 183	Jan. 214	Feb. 245	Mar. 273	Apr. 304	May 334	Jne. 365
July to	Aug. 31	Sep. 62	Oct. 92	Nov. 123	Dec. 153	Jan. 184	Feb. 215	Mar. 243	Apr. 274	May 304	Jne. 335	July 365
Aug. to	Sep. 31	Oct. 61	Nov. 92	Dec. 122	Jan. 153	Feb. 184	Mar. 212	Apr. 243	May 273	Jne. 304	July 334	Aug. 365
Sep. to	Oct. 30	Nov. 61	Dec. 91	Jan. 122	Feb. 153	Mar. 181	Apr. 212	May 242	Jne. 273	July 303	Aug. 334	Sep. 365
Oct. to	Nov. 31	Dec. 61	Jan. 92	Feb. 123	Mar. 151	Apr. 182	May 212	Jne. 243	July 273	Aug. 304	Sep. 335	Oct. 365
Nov. to	Dec. 30	Jan. 61	Feb. 92	Mar. 120	Apr. 151	May 181	Jne. 212	July 242	Aug. 273	Sep. 304	Oct. 334	Nov. 365
Dec. to	Jan. 31	Feb. 62	Mar. 90	Apr. 121	May 151	Jne. 182	July 212	Aug. 243	Sep. 274	Oct. 304	Nov. 335	Dec. 365

IX. COMPOUND INTEREST.

The subjoined table gives the amount of £1 put out at Compound Interest at various rates °/₀ and for different periods of years.

Yrs.	@ 2½%.	@ 3%.	@ 3½%.	@ 4%.	@ 4½%.	@ 5%.	@ 5½%.	@ 6%.
1	1·0250	1·0300	1·0350	1·0400	1·0450	1·0500	1·0550	1·0600
2	1·0506	1·0609	1·0712	1·0816	1·0920	1·1025	1·1130	1·1236
3	1·0768	1·0927	1·1087	1·1248	1·1411	1·1576	1·1742	1·1910
4	1·1038	1·1255	1·1475	1·1698	1·1925	1·2155	1·2388	1·2624
5	1·1314	1·1592	1·1876	1·2166	1·2461	1·2762	1·3069	1·3382
6	1·1596	1·1940	1·2297	1·2653	1·3022	1·3401	1·3788	1·4185
7	1·1886	1·2298	1·2722	1·3159	1·3608	1·4071	1·4546	1·5036
8	1·2184	1·2667	1·3168	1·3685	1·4221	1·4774	1·5846	1·5938
9	1·2488	1·3047	1·3629	1·4233	1·4861	1·5513	1·6190	1·6894
10	1·2800	1·3439	1·4106	1·4802	1·5529	1·6288	1·7081	1·7908
11	1·3120	1·3842	1·4599	1·5394	1·6228	1·7103	1·8020	1·8983
12	1·3448	1·4257	1·5110	1·6010	1·6958	1·7958	1·9012	2·0122
13	1·3785	1·4685	1·5689	1·6650	1·7722	1·8856	2·0057	2·1329
14	1·4129	1·5125	1·6186	1·7316	1·8519	1·9799	2·1160	2·2609
15	1·4483	1·5579	1·6758	1·8009	1·9352	2·0789	2·2324	2·3965
16	1·4845	1·6047	1·7339	1·8729	2·0223	2·1828	2·3552	2·5403
17	1·5216	1·5528	1·7946	1·9479	2·1133	2·2920	2·4848	2·6927
18	1·5596	1·7024	1·8574	2·0258	2·2084	2·4066	2·6214	2·8543
19	1·5986	1·7585	1·9225	2·1068	2·3078	2·5269	2·7656	3·0256
20	1·6386	1·8061	1·9897	2·1911	2·4117	2·6533	2·8873	3·2071
21	1·6795	1·8602	2·0594	2·2787	2·5202	2·7859	3·0782	3·3995
22	1·7215	1·9161	2·1315	2·3699	2·6336	2·9252	3·2475	3·6035
23	1·7646	1·9735	2·2061	2·4647	2·7521	3·0715	3·4261	3·8197
24	1·8087	2·0327	2·2833	2·5633	2·8760	3·2251	3·6146	4·0489
25	1·8539	2·0937	2·3632	2·6658	3·0053	3·3863	3·8134	4·2918
26	1·9002	2·1565	2·4459	2·7724	3·1406	3·5556	4·0231	4·5493
27	1·9478	2·2212	2·5315	2·8833	3·2820	3·7334	4·2444	4·8223
28	1·9965	2·2879	2·6201	2·9987	3·4297	3·9201	4·4788	5·1116
29	2·0464	2·3565	2·7118	3·1186	3·5840	4·1161	4·7241	5·4183
30	2·0975	2·4272	2·8067	3·2434	3·7453	4·3219	4·9839	5·7434
35	2·3782	2·8139	3·3336	3·9461	4·6673	5·5160	5·9947	7·6861
40	2·6851	3·2620	3·9593	4·8010	5·8164	7·0400	7·7426	10·2857
45	3·0379	3·7816	4·7024	5·8412	7·2482	8·9850	9·9999	13·7646
50	3·4371	4·3839	5·5850	7·1067	9·0326	11·4674	12·9154	18·4202

X. SQUARES AND CUBES OF NUMBERS
FROM 1 TO 234.

No.	Square.	Cube.	No.	Square.	Cube.	No.	Square.	Cube.
1	1	1	40	1600	64000	79	6241	493039
2	4	8	41	1681	68921	80	6400	512000
3	9	27	42	1764	74088	81	6561	531441
4	16	64	43	1849	79507	82	6724	551368
5	25	125	44	1936	85184	83	6889	571787
6	36	216	45	2025	91125	84	7056	592704
7	49	343	46	2116	97336	85	7225	614125
8	64	512	47	2209	103823	86	7396	636056
9	81	729	48	2304	110592	87	7569	658503
10	100	1000	49	2401	117649	88	7744	681472
11	121	1331	50	2500	125000	89	7921	704969
12	144	1728	51	2601	132651	90	8100	729000
13	169	2197	52	2704	140608	91	8281	753571
14	196	2744	53	2809	148877	92	8464	778688
15	225	3375	54	2916	157464	93	8649	804357
16	256	4096	55	3025	166375	94	8836	830584
17	289	4913	56	3136	175616	95	9025	857375
18	324	5832	57	3249	185193	96	9216	884736
19	361	6859	58	3364	195112	97	9409	912673
20	400	8000	59	3481	205379	98	9604	941192
21	441	9261	60	3600	216000	99	9801	970299
22	484	10648	61	3721	226981	100	10000	1000000
23	529	12167	62	3844	238328	101	10201	1030301
24	576	13824	63	3969	250047	102	10404	1061208
25	625	15625	64	4096	262144	103	10609	1092727
26	676	17576	65	4225	274625	104	10816	1124864
27	729	19683	66	4356	287496	105	11025	1157625
28	784	21952	67	4489	300763	106	11236	1191016
29	841	24389	68	4624	314432	107	11449	1225043
30	900	27000	69	4761	328509	108	11664	1259712
31	961	29791	70	4900	343000	109	11881	1295029
32	1024	32768	71	5041	357911	110	12100	1331000
33	1089	35937	72	5184	373248	111	12321	1367631
34	1156	39304	73	5329	389017	112	12544	1404928
35	1225	42875	74	5476	405224	113	12769	1442897
36	1296	46656	75	5625	421875	114	12996	1481544
37	1369	50653	76	5776	438976	115	13225	1520875
38	1444	54872	77	5929	456533	116	13456	1560896
39	1521	59319	78	6084	474552	117	13689	1601613

SQUARES AND CUBES OF NUMBERS—*Continued.*

No.	Square.	Cube.	No.	Square.	Cube.	No.	Square.	Cube.
118	13924	1643032	157	24649	3869893	196	38416	7529536
119	14161	1685159	158	24964	3944312	197	38809	7645373
120	14400	1728000	159	25281	4019679	198	39204	7762392
121	14641	1771561	160	25600	4096000	199	39601	7880599
122	14884	1815848	161	25921	4173281	200	40000	8000000
123	15129	1860867	162	26244	4251528	201	40401	8120601
124	15376	1906624	163	26569	4330747	202	40804	8242408
125	15625	1953125	164	26896	4410944	203	41209	8365427
126	15876	2000376	165	27225	4492125	204	41616	8489664
127	16129	2048383	166	27556	4574296	205	42025	8615125
128	16384	2097152	167	27889	4657463	206	42436	8741816
129	16641	2146689	168	28224	4741632	207	42849	8869743
130	16900	2197000	169	28561	4826809	208	43264	8998912
131	17161	2248091	170	28900	4913000	209	43681	9129329
132	17424	2291968	171	29241	5000211	210	44100	9261000
133	17689	2352637	172	29584	5088248	211	44521	9393931
134	17956	2406104	173	29929	5177717	212	44944	9528128
135	18225	2460375	174	30276	5268024	213	45369	9663597
136	18496	2515456	175	30625	5359375	214	45796	9800344
137	18769	2571353	176	30976	5451776	215	46225	9938375
138	19044	2628072	177	31329	5545233	216	46656	10077696
139	19321	2685619	178	31684	5639752	217	47089	10218313
140	19600	2744000	179	32041	5735339	218	47524	10360232
141	19881	2803221	180	32400	5832000	219	47961	10503459
142	20164	2863288	181	32761	5929741	220	48400	10648000
143	20449	2924207	182	33124	6028568	221	48841	10793861
144	20736	2985984	183	33489	6128487	222	49284	10941048
145	21025	3048625	184	33856	6229504	223	49729	11089567
146	21316	3112136	185	34225	6331625	224	50176	11239424
147	21609	3176523	186	34596	6434856	225	50625	11390625
148	21904	3241792	187	34969	6539203	226	51076	11543176
149	22201	3307949	188	35344	6644672	227	51529	11697083
150	22500	3375000	189	35721	6751269	228	51984	11852352
151	22801	3442951	190	36100	6859000	229	52441	12008989
152	23104	3511808	191	36481	6967871	230	52900	12167000
153	23409	3581577	192	36864	7077888	231	53361	12326931
154	23716	3652264	193	37249	7189057	232	53824	12487168
155	24025	3723875	194	37636	7301384	233	54289	12649337
156	24336	3796416	195	38025	7414875	234	54756	12812904

XI. TABLES OF PRIME NUMBERS.

It is often desirable that the student should know whether a number is prime or not. The following tables give all the primes up to ten thousand. The number at the head stands for thousands, the numbers at top of each column represent the hundreds, and the figures below give units and tens places.

Let it be required to determine whether 7591 be prime or composite.

We refer to the table with 7 in black type at the head on page 32. Then glancing down the column headed 5 we find 91. Therefore the number 7591 is prime.

Similarly searching to determine if 1939 is prime, we find from table headed 1 that it is not.

0

0	1	2	3	4	5	6	7	8	9
1	01	11	07	01	03	01	01	09	07
2	03	23	11	09	09	07	09	11	11
3	07	27	13	19	21	13	19	21	19
5	09	29	17	21	23	17	27	23	29
7	13	33	31	31	41	19	33	27	37
11	27	39	37	33	47	31	39	29	41
13	31	41	47	39	57	41	43	39	47
17	37	51	49	43	63	43	51	53	53
19	39	57	53	49	69	47	57	57	67
23	49	63	59	57	71	53	61	59	71
29	51	69	67	61	77	59	69	63	77
31	57	71	73	63	87	61	73	77	83
37	63	77	79	67	93	73	87	81	91
41	67	81	83	79	99	77	97	83	97
43	73	83	89	87		83		87	
47	79	93	97	91		91			
53	81			99					
59	91								
61	93								
67	97								
71	99								
73									
79									
83									
89									
97									

1

0	1	2	3	4	5	6	7	8	9
09	03	01	01	09	11	01	09	01	01
13	09	13	03	23	23	07	21	11	07
19	17	17	07	27	31	09	23	23	13
21	23	23	19	29	43	13	33	31	31
31	29	29	21	33	49	19	41	47	33
33	51	31	27	39	53	21	47	61	49
39	53	37	61	47	59	27	53	67	51
49	63	49	67	51	67	37	59	71	73
51	71	59	73	53	71	57	77	73	79
61	81	77	81	59	79	63	83	77	87
63	87	79	99	71	83	67	87	79	93
69	93	83		81	97	69	89	89	97
87		89		83		93			99
91		91		87		97			
93		97		89		99			
97				93					
				99					

2

0	1	2	3	4	5	6	7	8	9
03	11	03	09	11	03	09	07	01	03
11	13	07	11	17	21	17	11	03	09
17	29	13	33	23	31	21	13	19	17
27	31	21	39	37	39	33	19	33	27
29	37	37	41	41	43	47	29	37	39
39	41	39	47	47	49	57	31	43	53
53	43	43	51	59	51	59	41	51	57
63	53	51	57	67	57	63	49	57	63
69	61	67	71	73	79	71	53	61	69
81	79	69	77	77	91	77	67	79	71
83		73	81		93	83	77	87	99
87		81	83			87	89	97	
89		87	89			89	91		
99		93	93			93	97		
		97	99			99			

3

0	1	2	3	4	5	6	7	8	9
01	09	03	01	07	11	07	01	03	07
11	19	09	07	13	17	13	09	21	11
19	21	17	13	33	27	17	19	23	17
23	37	21	19	49	29	23	27	33	19
37	63	29	23	57	33	31	33	47	23
41	67	51	29	61	39	37	39	51	29
49	69	53	31	63	41	43	61	53	31
61	81	57	43	67	47	59	67	63	43
67	87	59	47	69	57	71	69	77	47
79	91	71	59	91	59	73	79	81	67
83		99	61	99	71	77	93	89	89
89			71		81	91	97		
			73		83	97			
			89		93				
			91						

4

0	1	2	3	4	5	6	7	8	9
01	11	01	27	09	07	03	03	01	03
03	27	11	37	21	13	21	21	13	09
07	29	17	39	23	17	37	23	17	19
13	33	19	49	41	19	39	29	31	31
19	39	29	57	47	23	43	33	61	33
21	53	31	63	51	47	49	51	71	37
27	57	41	73	57	49	51	59	77	43
49	59	43	91	63	61	57	83	89	51
51	77	53	97	81	67	63	87		57
57		59		83	83	73	89		67
73		61		93	91	79	93		69
79		71			97	91	99		73
91		73							87
93		83							93
99		89							99
		97							

5

0	1	2	3	4	5	6	7	8	9
03	01	09	03	07	01	23	01	01	03
09	07	27	09	13	03	39	11	07	23
11	13	31	23	17	07	41	17	13	27
21	19	33	33	19	19	47	37	21	39
23	47	37	47	31	21	51	41	27	53
39	53	61	51	37	27	53	43	39	81
51	67	73	81	41	31	57	49	43	87
59	71	79	87	43	57	59	79	49	
77	79	81	93	49	63	69	83	51	
81	89	97	99	71	69	83	91	57	
87	97			77	73	89		61	
99				79	81	93		67	
				83	91			69	
								79	
								81	
								97	

6

0	1	2	3	4	5	6	7	8	9
07	01	03	01	21	21	07	01	03	07
11	13	11	11	27	29	19	03	23	11
29	21	17	17	49	47	37	09	27	17
37	31	21	23	51	51	53	19	29	47
43	33	29	29	69	53	59	33	33	49
47	43	47	37	73	63	61	37	41	59
53	51	57	43	81	69	73	61	57	61
67	63	63	53	91	71	79	63	63	67
73	73	69	59		77	89	79	69	71
79	97	71	61		81	91	81	71	77
89	99	77	67		99		91	83	83
91		87	73				93	99	91
		99	79						97
			89						
			97						

7

0	1	2	3	4	5	6	7	8	9
01	03	07	07	11	07	03	03	17	01
13	09	11	09	17	17	07	17	23	07
19	21	13	21	33	23	21	23	29	19
27	27	19	31	51	29	39	27	41	27
39	29	29	33	57	37	43	41	53	33
43	51	37	49	59	41	49	53	67	37
57	59	43	51	77	47	69	57	73	49
69	77	47	69	81	49	73	59	77	51
79	87	53	93	87	59	81	89	79	63
	93	83		89	61	87	93	83	93
		97		99	73	91			
					77	99			
					83				
					89				
					91				

8

0	1	2	3	4	5	6	7	8	9
09	01	09	11	19	01	09	07	03	23
11	11	19	17	23	13	23	13	07	29
17	17	21	29	29	21	27	19	19	33
39	23	31	53	31	27	29	31	21	41
53	47	33	63	43	37	41	37	31	51
59	61	37	69	47	39	47	41	37	63
69	67	43	77	61	43	63	47	39	69
81	71	63	87	67	63	69	53	49	71
87	79	69	89		73	77	61	61	99
89	91	73			81	81	79	63	
93		87			97	89	83	67	
		91			99	93		87	
		93				99		93	
		97							

9

0	1	2	3	4	5	6	7	8	9
01	03	03	11	03	11	01	19	03	01
07	09	09	19	13	21	13	21	11	07
11	27	21	23	19	33	19	33	17	23
13	33	27	37	21	39	23	39	29	29
29	37	39	41	31	47	29	43	33	31
41	51	41	43	33	51	31	49	39	41
43	57	57	49	37	87	43	67	51	49
49	61	77	71	39		49	69	57	67
59	73	81	77	61		61	81	59	73
67	81	83	91	63		77	87	71	
91	87	93	97	67		79	91	83	
	99			73		89		87	
				79		97			
				91					
				97					

Note.—The distribution of prime numbers does not follow any known or discoverable law, but generally speaking primes diminish as the starting-point increases in value. For example, in the first 10,000 numbers there are 1230 primes: in the next 10,000 numbers (from 10,001 to 20,000) only 1033: and the number regularly diminishes with each advance as a starting-point. It might be thought from this consideration that such a number might be reached that all beyond would be composite numbers and primes would cease altogether. This, however, is not the case, for whilst we might name a succession of numbers so high that a million, or a million millions of them would pass without containing one prime, the fact remains that by proceeding further a prime number would ultimately be reached.

A curious property of one kind of prime numbers is that every prime of the form $4x + 1$ (where x is any integer number whatever) is made up of the sum of two perfect squares. Thus 53 is a prime of the form $4 \times 13 + 1$, and it is made up of the squares 49 and 4. Again 617 is a prime of the form $4 \times 154 + 1$, and it is also made up of two squares, 361 and 256. Other peculiarities of primes will be noticed in subsequent pages.

XII. ALIQUOT PARTS.

The subjoined table gives all the aliquot parts of £1, down to ½*d.*

		$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{5}$	$\frac{1}{6}$	$\frac{1}{8}$	$\frac{1}{10}$	$\frac{1}{12}$	$\frac{1}{20}$	$\frac{1}{40}$
	£ *s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
	1 0 0	10 0	6 8	5 0	4 0	3 4	2 6	2 0	1 8	1 0	0 6
$\frac{1}{2}$	10 0	5 0	3 4	2 6	2 0	1 8	1 3	1 0	0 10	0 6	0 3
$\frac{1}{3}$	6 8	3 4		1 8	1 4		0 10	0 8		0 4	0 2
$\frac{1}{4}$	5 0	2 6	1 8	1 3	1 0	0 10	0 7½	0 6	0 5	0 3	0 1½
$\frac{1}{5}$	4 0	2 0	1 4	1 0		0 8	0 6		0 4		
$\frac{1}{6}$	3 4	1 8		0 10	0 8		0 5	0 4		0 2	0 1
$\frac{1}{8}$	2 6	1 3	0 10	0 7½	0 6	0 5	0 3¾	0 3	0 2½	0 1½	0 ¾
$\frac{1}{10}$	2 0	1 0	0 8	0 6		0 4	0 3		0 2		
$\frac{1}{12}$	1 8	0 10		0 5	0 4		0 2½	0 2		0 1	0 ½
$\frac{1}{20}$	1 0	0 6	0 4	0 3		0 2	0 1½		0 1		
$\frac{1}{40}$	0 6	0 3	0 2	0 1½		0 1	0 ¾		0 ½		

XIII. THE METRIC SYSTEM.

MONEY.

Centimes.	Decime.	
10=	1	Franc.
100	10=	1

WEIGHT.

Milligrammes.	Centigramme.					
10=	1	Decigramme.				
100	10=	1	Gramme.			
1,000	100	10=	1	Decagramme.		
10,000	1,000	100	10=	1	Hectogramme.	
100,000	10,000	1,000	100	10=	1	Kilogramme.
1,000,000	100,000	10,000	1000	100	10=	1

Gramme=15½ English grains nearly (15·432 grs.).
Kilogramme=2⅕ lbs. avoir. nearly.
100 kilog., or a quintal, is equivalent to about 2 cwt.
1000 kilog, or 1 tonneau, is about 35 lbs. less than a common ton.

LENGTH.

Millimetres.	Centimetre.						
10=	1	Decimetre.					
100	10=	1	Metre.				
1,000	100	10=	1	Decametre.			
10,000	1,000	100	10=	1	Hectometre.		
100,000	10,000	1,000	100	10=	1	Kilometre.	
1,000,000	100,000	10,000	1,000	100	10=	1	Myriametre.
10,000,000	1,000,000	100,000	10,000	1000	100	10=	1

Metre=39·37037 inches. Kilometre=1100 yards nearly.

SURFACE.

Centiares.	Deciare.			
10=	1	Are.		
100	10=	1	Decare.	
1,000	100	10=	1	Hectare.
10,000	1,000	100	10=	1

Are=120 sq. yds. nearly (119·6 sq. yds.). Hectare=2½ acres nearly.

SOLIDITY.

Decisteres.	Stere.	
10=	1	**Decastere.**
100	10=	1

The stere=35⅓ cubic feet nearly.

CAPACITY.

Centilitres.	Decilitre.				
10=	1	**Litre.**			
100	10=	1	**Decalitre.**		
1,000	100	10=	1	**Hectolitre.**	
10,000	1,000	100	10=	1	**Kilolitre.**
100,000	10,000	1,000	100	10=	1

The litre is 1 quart nearly (1·76077 pints).

METRIC EQUIVALENTS OF ENGLISH WEIGHTS, &c.

1 inch = 2·54 centim.
1 foot = 30·48 centim.
1 yard = ·9144 metre.
1 rod = 5·029 old metres.
1 mile = 1·6093 kilometre.
1 sq. inch = 6·4528 sq. centim.
1 sq. foot = 929 sq. centimetres.
1 sq. yard = ·8361 sq. metre.
1 sq. rod = 25·29 centiares.
1 acre = 40·47 ares.

1 sq. mile = 256 hectares.
1 cub. inch = 16·39 c. centim.
1 cub. foot = 28320 c. centim.
1 cub. yard = ·7646 c. metre.
1 gallon = 3·786 litres.
1 bushel = ·3524 hectolitre.
1 troy grain = 64·8 milligrams.
1 ,, lb. = ·373 kilogram.
1 av. lb. = ·4536 kilogram.
1 ton =1·016 tonneau.

XIV. PRESENT VALUE OF AN ANNUITY OF ONE POUND FOR ONE YEAR UP TO THIRTY.

To find the present value of an Annuity of any number of pounds for any number of years up to 30. Search the table for the present value of £1 for the given time and the given rate. Multiply this value by the Annuity, taking aliquot parts for the shillings, if any.

Yrs.	2½%.	3%.	3½%.	4%.	4½%.	5%.
1	·97561	0·97087	0·96618	0·96154	0·95694	0·95238
2	1·92742	1·91347	1·89969	1·88609	1·87267	1·85941
3	2·85602	2·82861	2·80164	2·77509	2·74896	2·72325
4	3·76197	3·71710	3·67308	3·62990	3·58753	3·54595
5	4·64583	4·57971	4·51505	4·45182	4·43998	4·32948
6	5·50813	5·41719	5·32855	5·24214	5·15787	5·07569
7	6·34939	6·23028	6·11454	6·00205	5·89270	5·78637
8	7·17014	7·01969	6·87396	6·73274	6·59589	6·46321
9	7·97087	7·78611	7·60769	7·43533	7·26879	7·10782
10	8·75206	8·53020	8·31661	8·11090	7·91272	7·72173
11	9·51421	9·25262	9·00155	8·76048	8·52892	8·30641
12	10·25776	9·95400	9·66333	9·38507	9·11858	8·86325
13	10·98319	10·63496	10·30274	9·98565	9·68285	9·39357
14	11·69091	11·29607	10·92052	10·56312	10·22283	9·89864
15	12·38138	11·93793	11·51741	11·11839	10·73955	10·37966
16	13·05500	12·56110	12·09412	11·65230	11·23402	10·83777
17	13·71220	13·16612	12·65132	12·16567	11·70719	11·27407
18	14·35336	13·75351	13·18968	12·65930	12·15999	11·68959
19	14·97889	14·32380	13·70984	13·13394	12·59329	12·08532
20	15·58916	14·87747	14·21240	13·59033	13·00794	12·46221
21	16·18455	15·41502	14·69797	14·02916	13·40472	12·82115
22	16·76541	15·93692	15·16712	14·45112	13·78442	13·16300
23	17·33211	16·44361	15·62041	14·85684	14·14777	13·48857
24	17·88499	16·93554	16·05837	15·24696	14·49548	13·79864
25	18·42438	17·41315	16·48151	15·62208	14·82821	14·09394
26	18·95061	17·87684	16·89035	15·98277	15·14661	14·37519
27	19·46401	18·32703	17·28536	16·32959	15·45130	14·64303
28	19·96489	18·76411	17·66702	16·66306	15·74287	14·89813
29	20·45355	19·18845	18·03577	16·98371	16·02189	15·14107
30	20·93029	19·60044	18·39205	17·29203	16·28889	15·37245

XV. AMOUNT OF AN ANNUITY OF ONE POUND FOR TWO OR MORE YEARS.

Yrs.	2½%.	3%.	3½%.	4%.	4½%.	5%.
1	1·00000	1·00000	1·00000	1·00000	1·00000	1·00000
2	2·02500	2·03000	2·03500	2·04000	2·04500	2·05000
3	3·07563	3·09090	3·10623	3·12160	3·13703	3·15250
4	4·15252	4·18363	4·21494	4·24646	4·27819	4·31013
5	5·25633	5·30914	5·36247	5·41632	5·47071	5·52563
6	6·38774	6·46841	6·55015	6·63298	6·71689	6·80191
7	7·54743	7·66246	7·77941	7·89829	8·01915	8·14201
8	8·73612	8·89234	9·05169	9·21423	9·38001	9·54911
9	9·95452	10·15911	10·36850	10·58280	10·80211	11·02656
10	11·20338	11·46388	11·73139	12·00611	12·28821	12·57789
11	12·48347	12·80780	13·14199	13·48635	13·84118	14·20679
12	13·79555	14·19203	14·60196	15·02581	15·46403	15·91713
13	15·14044	15·61780	16·11303	16·62684	17·15991	17·71298
14	16·51895	17·08632	17·67699	18·29191	18·93211	19·59863
15	17·93193	18·59891	19·29568	20·02359	20·78405	21·57856
16	19·38022	20·15688	20·97103	21·82453	22·71934	23·65749
17	20·86473	21·76159	22·70502	23·69751	24·74171	25·84037
18	22·38635	23·41444	24·49969	25·64541	26·85508	28·13238
19	23·94601	25·11687	26·35718	27·67123	29·06356	30·53900
20	25·54466	26·87037	28·27968	29·77808	31·37142	33·06595
21	27·18327	28·67649	30·26947	31·96920	33·78314	35·71925
22	28·86286	30·53678	32·32890	34·24797	36·30338	38·50521
23	30·58443	32·45288	34·46041	36·61789	38·93703	41·43048
24	32·34904	34·42647	36·66653	39·08260	41·68920	44·50200
25	34·15776	36·45926	38·94986	41·64591	44·56521	47·72710
26	36·01171	38·55304	41·31310	44·31174	47·57064	51·11345
27	37·91200	40·70963	43·75906	47·08421	50·71132	54·66913
28	39·85980	42·93092	46·29063	49·96758	53·99333	58·40258
29	41·85630	45·21885	48·91080	52·96629	57·42303	62·32271
30	43·90270	47·57542	51·62268	56·08494	61·00707	66·43885
35	54·92821	60·46208	66·67401	73·65223	81·49662	90·32031
40	67·40255	75·40126	84·55028	95·02552	107·03032	120·79977
45	81·51613	92·71986	105·78167	121·02939	138·84997	159·70016
50	97·48435	112·79687	130·99791	152·66708	178·50303	209·34800

XVI. LOGARITHMS.

Logarithms of R = (1 + *r*).

R.	Logar.	R.	Logar.	R.	Logar.	R.	Logar.
1·0025	·0010843	1·0175	·0075344	1·0325	·0138900	1·0475	·0201540
1·0050	·0021660	1·0200	·0086001	1·0350	·0149403	1·0500	·0211892
1·0075	·0032450	1·0225	·0096633	1·0375	·0159881	1·0525	·0222221
1·0100	·0043213	1·0250	·0107238	1·0400	·0170333	1·0550	·0232524
1·0125	·0053950	1·0275	·0117818	1·0425	·0180760	1·0575	·0242803
1·0150	·0064660	1·0300	·0128372	1·0450	·0191162	1·0600	·0253058

LOGARITHMS OF NUMBERS.

The indices are omitted, and must be supplied by the calculator.

1	·0000000	31	·4913617	61	·7853298	91	·9590414
2	·3010300	32	·5051500	62	·7923917	92	·9637878
3	·4771213	33	·5185139	63	·7993405	93	·9684829
4	·6020600	34	·5314789	64	·8061800	94	·9731279
5	·6989700	35	·5440680	65	·8129134	95	·9777236
6	·7781513	36	·5563025	66	·8195439	96	·9822712
7	·8450980	37	·5682017	67	·8260748	97	·9867717
8	·9030900	38	·5797836	68	·8325089	98	·9912261
9	·9542425	39	·5910646	69	·8388491	99	·9956352
10	·0000000	40	·6020600	70	·8450980	100	·0000000
11	·0413927	41	·6127839	71	·8512583	101	·0043214
12	·0791812	42	·6232493	72	·8573325	102	·0086002
13	·1139434	43	·6334685	73	·8633229	103	·0128372
14	·1461280	44	·6434527	74	·8692317	104	·0170333
15	·1760913	45	·6532125	75	·8750613	105	·0211893
16	·2041200	46	·6627578	76	·8808136	106	·0253059
17	·2304489	47	·6720979	77	·8864907	107	·0293838
18	·2552725	48	·6812412	78	·8920946	108	·0334238
19	·2787536	49	·6901961	79	·8976271	109	·0374265
20	·3010300	50	·6989700	80	·9030900	110	·0413927
21	·3222193	51	·7075702	81	·9084850	111	·0453230
22	·3424227	52	·7160033	82	·9138139	112	·0492180
23	·3617278	53	·7242759	83	·9190781	113	·0530784
24	·3802112	54	·7323938	84	·9242793	114	·0569049
25	·3979400	55	·7403627	85	·9294189	115	·0606978
26	·4149733	56	·7481880	86	·9344985	116	·0644580
27	·4313638	57	·7558749	87	·9395193	117	·0681859
28	·4471580	58	·7634280	88	·9444827	118	·0718820
29	·4623980	59	·7708520	89	·9493900	119	·0755470
30	·4771213	60	·7781513	90	·9542425	120	·0791812

XVII. SIGNS USED IN ARITHMETIC.

+ read "plus," the sign of addition or increase.
− „ "minus," the sign of diminution or decrease.
× „ "into," the sign of multiplication.
÷ „ "by," the sign of division.
~ signifies and is read "the difference between."
= read "equals," the sign of equality.
> „ "is greater than," sign of inequality.
< „ "is less than," sign of inequality.
≷ „ "is greater or less than."
√ the radix or root sign.
{[()]} brackets, used to combine quantities into one term.
$^{\circ}/_{0}$ per cent or per hundred.
£ sign used to denote pounds in money.
s. „ „ „ shillings.
d. „ „ „ pence.
q. „ „ „ farthings.
∴ read "therefore."
∵ „ "because."

XVIII. TECHNICAL TERMS.

Abstract Number, a number having no reference to objects.

Account Sales, a statement of sales and proceeds of goods sent for sale on commission.

Addend, a quantity or number to be added.

Aliquot Part, a concrete factor; a part of a quantity such that if added to itself so many times it will make up the quantity.

Amount, the sum made up of the principal and its accrued interest.

Area, the superficial content of any plane figure in terms of a quantity taken as a unit.

Arithmetic, the science of numbers.

Brokerage, charge made by a broker for performing certain services, as for buying or selling stock.

Cancelling, throwing out similar and equal factors from both terms of a fraction.

Cloff, an allowance (obsolete) of 2 lbs. in each 3 cwts. for turning of beam.

Complement, that which makes up or supplies a deficiency; the number or quantity which when added to the smaller of two numbers makes up the larger number; an increment.

Complementary, forming a complement.

Complex Fraction, a fraction not having its terms simple integer numbers.

Composite Number, a number made up of factors greater than unity.

Compound Fraction, a fraction of a fraction.

Concrete Number, a number having reference to objects.

Consignment, goods or cargo sent for sale to an agent.

Cube, the third power of any number: a solid having six equal square sides.

Decimal, a fraction with an *understood* denominator of 10 or some power of 10.

Denominator, the number which shows the kind or denomination; the lower term in a vulgar fraction.

Digit, a single figure—the digits are 1, 2, 3, 4, 5, 6, 7, 8, 9, 0.

Discount, the allowance made from a sum of money for paying it before it is due; an allowance on the amount of a bill.

Dividend, the number to be divided.

Equation, a statement of equality as existing between two quantities.

Factor, a measure or multiplier; the factors of a number are the numbers that produce it by being multiplied together.

Figure, arithmetically is a written sign or symbol used to represent a certain number; a digit.

Fraction, a part or parts of unity; a portion of any sum or quantity regarded as a unit.

Fractional Number, a number or quantity expressed in parts.

Gross Weight, the whole weight of any article, box &c. included.

Improper Fraction, a fraction equal to or greater than unity.

Increment, a complement; the difference between two unequal numbers.

Incremental, serving to make up; complementary.

Insurance, a contract to secure against loss by fire, &c., or to pay a certain sum at a person's death.

Integral Number, an integer, or a whole number.

Interest, money paid for the use of money.

Invoice, a detailed account of goods sold or sent.

Item, a detail or entry; a single particular in a list or account.

Measure, a factor: a quantity or number contained exactly in another quantity or number.

Mixed Number, a number made up of an integer and a fraction.

Multiple, a quantity containing another quantity exactly.

Multiplicand, the quantity to be repeated or multiplied.

Net Weight, what remains after all deductions have been made.

Notation, the art of expressing numbers in figures.

Numeration, the art of expressing numbers in words.

Numerator, the number which shows how many fractional parts are taken; the upper term in a vulgar fraction.

Premium, the amount paid on a policy for insurance; the sum by which the value of stock or shares is greater than the original value.

Present Worth, the present value of a sum payable at a future date; the amount that results when discount is allowed for.

Prime Cost, the original value or price of anything.

Prime Number, a number having no factors but unity and itself, or not divisible by any number but 1.

Principal, the money lent, on which interest is paid.

Product, the number resulting from the multiplication of two or more numbers together.

Proper Fraction, a fraction less than unity.

Quotient, the "How often?" or answer to a division question.

Ratio, the relation which one quantity bears to another with respect to magnitude.

Reciprocal of any quantity is unity divided by that quantity: thus the reciprocal of 6 is $\frac{1}{6}$.

Rectangle, a four-sided figure having all its angles right.

Simple Fraction, a fraction having its terms simple integer numbers.

Solid, a body having length, breadth, and thickness or depth.

Stock, the trading capital of any merchant or company.

Surd, a quantity whose root cannot be exactly found.

Suttle, the weight after tare has been allowed for.

Tare, the weight of the box or barrel containing the goods.

Tret, an allowance of 4 lbs. in every 104 lbs. in goods liable to waste.

Unit, any number, object, or objects considered as a whole.

INTEGRAL ARITHMETIC.

NOTATION AND NUMERATION.

THE SHORT SYSTEM.

	of Sextillions.			of Quintillions.			of Quadrillions.			of Trillions.			of Billions.			of Millions.			of Thousands.			of Units.		
Units	Hundreds	Tens	Units	Hundreds	Tens	Units	Hundreds	Tens	Units	Hundreds	Tens	Units	Hundreds	Tens	Units	Hundreds	Tens	Units	Hundreds	Tens	Units	Hundreds	Tens	Units
3	4	5	6	8	6	3	4	5	7	9	2	0	3	0	4	5	6	7	0	2	1	5	6	1
	8			7			6			5			4			3			2			1		
il- s,	Sextillions,			Quintillions,			Quadrillions,			Trillions,			Billions,			Millions,			Thousands,			Units.		

THE LONG SYSTEM.

of Quadrillions.					of Trillions.						of Billions.						of Millions.						of Units.					
Tens of Thousands	Thousands	Hundreds	Tens	Units	Hundreds of Thousands	Tens of Thousands	Thousands	Hundreds	Tens	Units	Hundreds of Thousands	Tens of Thousands	Thousands	Hundreds	Tens	Units	Hundreds of Thousands	Tens of Thousands	Thousands	Hundreds	Tens	Units	Hundreds of Thousands	Tens of Thousands	Thousands	Hundreds	Tens	Units
8	7	1	2	3	4	5	6	8	7	3	4	5	7	9	2	0	3	0	4	5	6	7	0	2	1	5	6	1
5					4						3						2						1					
adrillions,					Trillions,						Billions,						Millions,						Units.					

The two systems of Notation in general use are exhibited on the preceding page.

In the first the line of figures is divided into periods composed of three digits each—this system is suitable for comparatively small numbers.

In the second table the periods consist of six figures each—this system is adapted for very large numbers.

RULE I.

To express any number in figures which is already given in words.

1°. Write down a line of ciphers and divide them into as many periods (in the Short or Long System, whichever is desired) as the number requires.

2°. Set down the several periods of the number under their proper heads and fill up any vacancies with ciphers.

Note.—After some practice the line of ciphers should be discarded and the number at once written down without its aid.

Exercise 1.

Express in figures:—

(1.) Five hundred and one.

(2.) Three thousand and seventeen.

(3.) Fifteen thousand five hundred.

(4.) One hundred thousand and sixty.

(5.) Three hundred and six thousand and seven.

(6.) Four million twenty thousand six hundred.

(7.) Ten million ten thousand and ten.

(8.) One hundred and seven millions and sixteen.

(9.) Three billion, three thousand and three.

(10.) Thirty billion, three million, thirty thousand and thirteen.

*(11.) One hundred and six thousand million and sixteen hundred.

*(12.) Three thousand billion, thirteen thousand million and thirteen thousand.

*(13.) Fourteen thousand trillion, fourteen thousand million and fourteen.

*(14.) One hundred thousand trillion, fifty billion, four thousand and one.

---

* These by the Long System of Notation.

RULE II.

To write in words, or to read, any number already given in figures.

1°. Beginning at the right hand, point off the number into periods of three or six figures (according as the short or long period system is intended).

2°. Read the number from the left hand, adding the name of the period to the number expressed by the figures which it contains.

Exercise 2.

Write in words the following numbers in both notations:—

(1.) 123456789.
(2.) 120300405.
(3.) 120030045.
(4.) 100023.
(5.) 900287006.
(6.) 700600050.
(7.) 12000030040.
(8.) 4500060070008.
(9.) 28070040090070.
(10.) 1230040500607000.

*(11.) 10203000400005006.
(12.) 120304005060070800 9.
(13.) 1020030004000050000 06.
(14.) 10000006000005000040000 30020.
(15.) 1234000056780000900001.
(16.) 1002304000000001001000 07890.
(17.) 100020000030400009080067.
(18.) 98706500345067890 54210.
(19.) 2133145067089213870062984000000.
(20.) 1000000640000070090008000007000 63.

Additional exercises in this rule may be found in the questions and examples given on the simple rules.

---

* **This and the following to be read by the "*Long*" Notation.**

ROMAN NOTATION.

The following notation was in use among the Romans, and is now occasionally employed as a distinctive character for special purposes:—

I	stands for	1.	CIƆ	stands for	1,000.
IIII or IV	"	4.	CCIƆƆ	"	10,000.
V	"	5.	CCCIƆƆƆ	"	100,000.
X	"	10.	V̄	"	5,000.
L	"	50.	C̄	"	100,000.
C	"	100.	VII	"	7.
D	"	500.	XIV	"	14.
M	"	1,000.	XXX	"	30.
IƆ	"	500.	XL	"	40.
IƆƆ	"	5,000.	XC	"	90.
IƆƆƆ	"	50,000.	CC	"	200.

If any letter be followed by one of equal or less value, the total value is equal to the sum of the two taken together; but if a letter be preceded by one of less value, the difference of their separate values is to be understood.

Exercise 2a.

Express in Roman notation:—

(1.) 505.
(2.) 1783.
(3.) 90048.
(4.) 62132.
(5.) 41579.
(6.) 820037.
(7.) 80405.
(8.) 1021314.
(9.) 578145.
(10.) 2135720.

Express in the common notation:—

(11.) MDCCLXXXIX.
(12.) CIƆIƆCCCLXXVIII.
(13.) IƆƆIƆLV.
(14.) MMCCCCXC.
(15.) C̄V̄DLXII.
(16.) CCCIƆƆƆIƆƆƆV̄DIX.
(17.) CCIƆƆDXLIV.
(18.) IƆƆƆIƆƆIƆXCIX.

SIMPLE ADDITION.

Simple Addition is the method of finding the sum of two or more numbers, or of finding one number or quantity which shall be equal to two or more numbers or quantities taken together.

The scholar will notice that the term "Simple" is used merely in opposition to the word "Compound" (introduced at a later stage), and means either that the numbers added are abstract, or that if objects are admitted there cannot possibly be more than one order, sort, or kind considered at the same time and in the same calculation. In integral quantities "Addition" is *always simple in one view of it,* but the above distinction should be carefully borne in mind.

RULE III.

To find the sum of two or more numbers.

1°. Place the numbers under each other—units under units, tens under tens, &c., and draw a line beneath the last row.

2°. Add up the figures or digits of the unit column. If the sum be greater than nine put down under the unit column the unit figure of the sum, carrying or adding the tens figure to the next or "ten" column, which is to be added in the same way as the unit column.

3°. Set down as before the unit figure of the sum and carry as in the first case to next column. Thus proceed till all the columns are added, and put down the full sum of the last column.

Note.—The addition tables *must be perfectly mastered* whilst the pupil is at this rule; the addition squares here provided will supply excellent exercises on those tables.

Illustrative Example.—Add together 30141, 251, 5917, and 16.

We here place the numbers under each other, units under units, &c. Next we add the units column, putting the unit figure of the sum down and carrying the one to the ten column. Adding all the columns similarly we find the sum to be 36325.

$$\begin{array}{r} 30141 \\ 251 \\ 5917 \\ 16 \\ \hline 36325 \\ \hline \end{array}$$

Exercise 3.

(1.)	(2.)	(3.)	(4.)	(5.)	(6.)	(7.)
1	2	2	2	1	12	21
2	2	1	2	1	21	12
1	1	1	2	1	22	11
2	1	2	1	2	11	12
1	2	2	1	2	22	21
2	2	1	1	1	22	22
1	1	1	2	2	11	12
	2	2	1	1		

(8.)	(9.)	(10.)	(11.)	(12.)	(13.)
231	333	234	345	555	4563
223	111	432	435	444	3654
331	222	422	543	333	6534
321	311	344	354	453	3456
311	211	214	453	435	4365
312	123	324	534	534	3645

(14.)	(15.)	(16.)	(17.)	(18.)
2356	5674	3275	6785	56789
3562	6754	5732	5678	67895
3265	4576	7523	6785	78956
2653	5764	5237	7856	89567
6532	4675	3752	5687	95678
4564	6457	5723	7586	65798

(19.)	(20.)	(21.)	(22.)
98765	918273	739451	64935039
87659	182739	43267	3729015
76598	827391	849130	95206813
65987	739128	693513	5984315
59876	281937	79484	19327117
32542	193782	107325	94863574

(23.)	(24.)	(25.)	(26.)	(27.)	(28.)
74296583	6543	9873	4019	321457	1234
1027968	807	361	50037	98604	5678
70624	54091	10458	88	4237	9123
4968735	9999	94	9900	68888	4567
26587469	38	7290	390		8912
42897					3456

(29.)	(30.)	(31.)	(32.)
99999	11111	99887	123456
88888	22222	76655	789123
77777	33333	44332	456789
66666	44444	21199	998877
54321	55555	88776	665544
98765	67891	65544	332211
43219	23456	33221	887766
87654	78912	19988	554433
32198	34567	77665	221199
76543	89123	54433	887777
21987	45678	22119	766655
65432	91234	98877	544433
19876	56789	66554	322211
54321	12345	33221	199888

"*SQUARE*" ADDITIONS.

SQUARE No. 1.

8 3 3 8 9 9 8 8 7 7 6 6 5 5 4 4
4 9 3 2 1 4 5 7 8 6 3 8 6 4 1 6 3
2 8 7 2 3 8 9 2 6 7 2 4 8 3 3
3 8 9 6 9 3 6 7 2 4 8 8 2 2
4 9 2 2 8 6 3 4 5 7 4 7 4 2
4 9 6 4 9 2 5 7 5 1
5 3 7 7 7 3 7 6 7 1
6 3 3 8 3 6 2 5 8 9
6 7 2 9 2 4 5 1 8 8 9 3 4 8 9
7 7 5 7 8 1 3 1 2 9 8 6 3 9 8
8 8 9 6 7 2 3 4 8 8 9 9 6 3 8
7 8 4 2 3 6 8 9 4 5 7 9 2 3 7
5 3 2 1 8 6 5 6 7 9 8 4 5 7 9 8

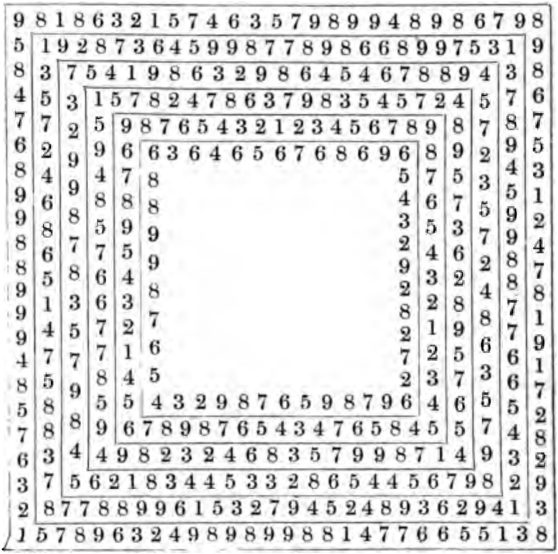
Take the inside square first; begin at any one figure and add round the four sides, noting the result; begin at the same figure but proceed in the opposite direction. The result should be the same. Now take the next figure as the starting figure. Add up both ways and the sum should be unchanged. Thus proceed from each figure in order as a starting point in two directions, and each square will furnish twice as many different exercises as there are figures in the square.

SQUARE No. 2.

368	381	394	407	420	301	314	327	340	353	366
380	393	406	419	311	313	326	339	352	365	367
392	405	418	310	312	325	338	351	364	377	379
404	417	309	322	324	337	350	363	376	378	391
416	308	321	323	336	349	362	375	388	390	403
307	320	333	335	348	361	374	387	389	402	415
319	332	334	347	360	373	386	399	401	414	306
331	344	346	359	372	385	398	400	413	305	318
343	345	358	371	384	397	410	412	304	317	330
355	357	370	383	396	409	411	303	316	329	342
356	369	382	395	408	421	302	315	328	341	354

This square gives no less than forty-six separate additions vertically, up and down, horizontally, in both directions, and also diagonally. The sum is in every case the same. The cross additions are very valuable, and should be faithfully performed.

SQUARE No. 3.



9 8 1 8 6 3 2 1 5 7 4 6 3 5 7 9 8 9 9 4 8 9 8 6 7 9 8
5 8 4 7 6 8 9 9 8 8 9 9 9 4 8 5 7 6 3 2
9 8 6 7 5 3 1 2 4 7 8 1 9 1 7 2 8 2 9 3
1 5 7 8 9 6 3 2 4 9 8 9 8 9 9 8 8 1 4 7 7 6 6 5 5 1 3 8

1 9 2 8 7 3 6 4 5 9 9 8 7 7 8 9 8 6 6 8 9 9 7 5 3 1
3 5 7 2 4 6 8 6 5 1 4 7 5 8 8 3 7
3 7 8 9 4 5 9 9 8 8 7 7 6 6 5 4 3 2
8 7 7 8 8 9 9 6 1 5 3 2 7 9 4 5 2 4 8 9 3 6 2 9 4 1

7 5 4 1 9 8 6 3 2 9 8 6 4 5 4 6 7 8 8 9 4
3 2 9 9 8 7 8 3 5 7 9 8 4
5 7 2 3 5 7 2 4 8 6 3 5 7 9
5 6 2 1 8 3 4 4 5 3 3 2 8 6 5 4 4 5 6 7 9 8

1 5 7 8 2 4 7 8 6 3 7 9 8 3 5 4 5 7 2 4
5 9 4 8 5 7 6 6 7 7 8 5 9
8 9 5 7 3 6 2 8 9 5 7 6 5
4 9 8 2 3 2 4 6 8 3 5 7 9 9 8 7 1 4

9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9
6 7 8 9 5 4 3 2 1 4 5
8 7 6 5 4 3 2 1 2 3 4
6 7 8 9 8 7 6 5 4 3 4 7 6 5 8 4 5

6 3 6 4 6 5 6 7 6 8 6 9 6
8 8 9 9 8 7 6 5
5 4 3 2 9 2 8 2 7 2
4 3 2 9 8 7 6 5 9 8 7 9 6

SIMPLE COMPLEMENTARY ADDITION

Simple Complementary Addition is the method of finding the difference between any two unequal numbers, or the complement which requires to be added to one number to make it equal to another number.

The Rule which, it is believed, for the first time is now substituted for "Subtraction" dispenses with all needless processes, and the pupil may now determine the difference between two unequal numbers in the same way exactly as he calculates the sum of the same two numbers, and without introducing one fresh element that is not contained in the "*Unit*" *Addition Table*, with which at this stage he is perfectly familiar.

The fundamental principle in Complementary Addition is seen in any one of the statements to be found in Table I. (page 15). We will take a random line for illustration, 5+8=13, which is read, 5 plus or increased or complemented by 8 equals 13. As there are three numbers here, so we may read the equation in three ways. First, the sum of 5 and 8 is 13; second, the difference of 5 and 13 is 8; third, the difference between 8 and 13 is 5. Therefore, the complement of 5 to make 13 is 8, and the complement of 8 to make 13 is 5. Suppose now that one of these addends (5 or 8) be omitted the pupil has only to supply the complement, which he knows to be either 8 or 5, in order to make 13. This principle applied simply and as in the Rule of "Simple Addition" (so far as carrying is concerned) will determine in the easiest manner possible the difference between the unequal numbers prescribed.

RULE IV.

To find the difference between any two unequal numbers.

1°. Write down the smaller number under the larger—units under units, tens under tens, &c., as in simple addition, drawing a line below the two numbers.

2°. Beginning at the right hand, think or find what number (the complement) added to the lower figure will make the unit figure of the resulting sum the same as the upper unit figure or digit.

3°. Put down the complement thus found, carrying (if necessary) one to the lower tens figure in operating on the next pair.

4°. Proceed with each successive pair in the same manner.

Illustrative Examples.

No. 1. Find the difference between 894736 and 214502.

$$\begin{array}{r} 894736 \\ \underline{214502} \\ \underline{\underline{680234}} \end{array}$$

First 2 and 4 (put it down) are 6; 0 and 3 (put it down) make 3; 5 and 2 (put it down) are 7; 4 and 0 (put it down) make 4; 1 and 8 (put it down) are 9; 2 and 6 (put it down) are 8, and the sum is finished.

No. 2. Find the difference between 1035014 and 786418.

$$\begin{array}{r} 1035014 \\ \underline{786418} \\ \underline{\underline{248596}} \end{array}$$

We proceed as follows: 8 and 6 (put it down) make 14, carry 1 from 14 and say 1 and 1 are 2; 2 and 9 (put it down) make 11, carry the 1 from 11 and say 4 and 1 are 5; 5 and 5 (put it down) make 10; carry 1 and say 7 and 8 (put it down) are 15, carry 1; 9 and 4 (put it down) make 13, carry 1 and say 8 and 2 (put it down) make 10, and the work is complete.

Exercise 4.

(1.)	(2.)	(3.)	(4.)
9320541	6412630216	7832165843	812356
937465	82470325	687357289	75849

(5.)	(6.)	(7.)	(8.)
9768452	2324596	3547216	953790
839204	584468	657381	846781

(9.)	(10.)	(11.)	(12.)
5287201	3229889	80000	8201572
2057312	2057312	57735	6275264

(13.) 12003708 3104219	(14.) 6001501 5102503	(15.) 6980357 4923748	(16.) 12003405 4056417
(17.) 61321401 5781432	(18.) 5003005 500306	(19.) 243507 199887	(20.) 41632198 38638499
(21.) 76054003 63056542	(22.) 60003004 6034005	(23.) 25410632 18529748	(24.) 63219876 23998345
(25.) 80030030 76054034	(26.) 21572157 11583188	(27.) 111118867 84029678	(28.) 30303030 24430303
(29.) 30457214 28923875	(30.) 456789012 389899543	(31.) 66006606 57076607	(32.) 20000606 10000707
(33.) 5000001000 4400031005	(34.) 815037 347089	(35.) 1230456 987065	(36.) 142360 78957
(37.) 7102365 2893678	(38.) 1020304 670807	(39.) 1002003 368205	(40.) 5013014 1784053
(41.) 60500403 26890657	(42.) 54003201 37004508	(43.) 8215720 6715721	(44.) 3150642 2850657
(45.) 12300456 3600489	(46.) 10003000 1234506	(47.) 70060054 68060166	(48.) 4000000 3989989

(49.) 3106705201 2943896403	(50.) 77665544 76895675	(51.) 89654321 79684364

(52.) 7542361 2987605	(53.) 4210003000 3862014051

SIMPLE MULTIPLICATION.

Simple Multiplication is the method of finding one number or quantity which is equal to another number or quantity repeated any given number of times. Sometimes it has been called a short method of addition, where all the addends are equal. There are two general and several special rules under this heading, but as some of the latter require a knowledge of division they are of necessity deferred until that subject has been treated (see Rules XXII.–XXXI., p. 68–72). It should be remembered that the multiplier must always be regarded as an abstract number. The pupil, of course, must be perfectly familiar with the multiplication table.

Rule V.

To multiply by any number up to and including 19.

1°. Place the multiplier under the unit figure (and tens figure if the multiplier contains two digits) of the multiplicand, and draw a line underneath.

2°. Multiply each figure of the multiplicand (beginning at the unit digit) by the multiplier in succession, in every case putting down the unit figure of the product vertically under the figure being multiplied, carrying the other figure or figures to the next product.

3°. In multiplying the last left-hand figure put down the entire result.

Illustrative Example.—Multiply 81504 by 17.

We say 17 × 4 = 68, put down 8 and carry 6; 17 × 0 = 0 and 6 are 6, put it down; 17 × 5 = 85, set down 5 and carry 8; 17 × 1 = 17 and 8 are 25, set down 5 and carry 2; 17 × 8 = 136 and 2 are 138, put it all down.

$$\begin{array}{r}81504\\ 17\\ \hline 1385568\\ \hline\hline\end{array}$$

Note.—Another method of working is to proceed thus: Multiply by 7 and add the back figure in as follows to each product: 7 × 4 = 28, 8 and carry 2; 7 × 0 = 0 and 2 are 2 and 4 are 6, set it down; 7 × 5 = 35 and 0 = 35, 5 and carry 3; 7 × 1 = 7 carry 3 make 10 and 5 = 15, set down 5 and carry 1; 7 × 8 + 1 = 57 and 1 = 58, set down 8 and carry 5; 5 and back figure 8 make 13, set it down. This plan is generally preferred when *multiplying by* numbers ranging between 12 and 20.

Exercise 5.

(1.) 3215467 × 2, 3, 5, 7, 11, 13, 17, 19.
(2.) 8451276 × 4, 5, 6, 7, 9, 11, 16, 17.
(3.) 4815672 × 2, 3, 5, 6, 8, 12, 14, 16.
(4.) 1842765 × 3, 5, 7, 9, 11, 13, 15, 17.
(5.) 8124675 × 4, 6, 8, 10, 12, 14, 16, 18.
(6.) 3456789 × 13, 14, 15, 16, 17, 18, 19.
(7.) 9182736 × 14, 15, 16, 17, 18, 19.
(8.) 4561235 × 15, 16, 17, 18, 19.
(9.) 2431589 × 16, 17, 18, 19.
(10.) 7786923 × 18, 19.
(11.) 1230456078904 × 17, 18, 19.
(12.) 9080706543201 × 17, 18, 19.
(13.) 347257895468 × 16, 17, 19.
(14.) 2963587654321 × 13, 17, 19.
(15.) 21133667788995 × 13, 17, 19.

RULE VI.

To multiply by any number exceeding 20.

1°. Place the quantities as in the preceding rule.

2°. Multiply by the unit figure as already directed; then multiply the upper line by the tens digit, being careful to place the first figure of the product vertically under the multiplier in use for the time being; proceed to the hundred digit and employ it in the same way, and so on with any and all other figures of the multiplier.

3°. Add up the results for the final product.

Illustrative Example.—Multiply 54321 by 1234.

$$\begin{array}{rcrl}
54321 & & & \\
1234 & & & \\ \hline
217284 & = & 4 & \text{times top line.} \\
162963 & = & 30 & \text{,, \quad ,,} \\
108642 & = & 200 & \text{,, \quad ,,} \\
54321 & = & 1000 & \text{,, \quad ,,} \\ \hline
67032114 & = & 1234 & \text{,, \quad ,,} \\ \hline\hline
\end{array}$$

(The example needs no explanation.)

Exercise 6.

(1.) 24683 × 87, 261, 783.
(2.) 12345 × 93, 279, 837.
(3.) 23456 × 65, 195, 585.
(4.) 34567 × 58, 232, 928.
(5.) 45768 × 47, 188, 752.
(6.) 28357 × 59, 236, 944.
(7.) 98675 × 67, 268, 1072.
(8.) 83963 × 73, 292, 1168.
(9.) 74525 × 82, 328, 1312.
(10.) 95969 × 98, 588, 3528.
(11.) 88776 × 101, 606, 3636.
(12.) 66554 × 111, 666, 3996.
(13.) 47658 × 133, 798, 4788.
(14.) 91325 × 126, 756, 4536.
(15.) 26857 × 118, 708, 4248.
(16.) 59730215 × 7016.
(17.) 64132708 × 516.
(18.) 71523097 × 402607.
(19.) 467259873 × 397506.
(20.) 82653 × 19800.
(21.) 59872 × 47930.
(22.) 2895 × 35700.
(23.) 85762 × 3109.
(24.) 98500 × 9070.
(25.) 3003 × 79000.
(26.) 420597 × 639.
(27.) 2035674 × 396.
(28.) 17943 × 5079.
(29.) 1009087 × 600543.
(30.) 59500198 × 5042.
(31.) 30030000 × 400080.
(32.) 602000208 × 900007.
(33.) 147297 × 6789.
(34.) 100100010 × 5005.
(35.) 5009 × 410.
(36.) 740162 × 305607.
(37.) 804106 × 47903.
(38.) 1863 × 365 × 24.
(39.) 18603 × 365.
(40.) 1863 × 3650.
(41.) 129847 × 468.
(42.) 37800 × 7950.
(43.) 2468 × 3057.
(44.) 3764 × 2087.
(45.) 537152 × 763.

RULE VII.

To multiply by means of factors.

1°. Multiply the multiplicand by any one of the facto composing the multiplier.

2°. Multiply the product thus obtained by any other one the factors, and this result by a third factor if there be many.

3°. The last product is the required multiple.

Illustrative Example.—Multiply 198463 by 168.

We may here use either the factors 12 and 14; 3, 7 and 8; 2, 7 and 12; or 6, 7 and 4. We will take the last.

(No explanation is necessary.)

$$\begin{array}{r} 198463 \\ 7 \\ \hline 1389241 \\ 6 \\ \hline 8335446 \\ 4 \\ \hline 33341784 \\ \hline \hline \end{array}$$

Exercise 7.—Factorial Multiplication.

(1.) 9182776 × 22, 24, 26, 28, 33, 39, 49.
(2.) 5432184 × 27, 57, 77, 45, 56, 66, 96.
(3.) 7015834 × 42, 44, 48, 81, 84, 88, 99.
(4.) 2108605 × 108, 121, 132, 144, 156, 168, 198.
(5.) 3507953 × 234, 294, 162, 342, 462, 336, 396.
(6.) 1234567 × 672, 304, 336, 567, 588, 616, 1344.
(7.) 9876543 × 693, 756, 847, 924, 1008, 1092, 1176.
(8.) 2819378 × 702, 882, 486, 1026, 1386, 1188, 1458.
(9.) 5577009 × 2016, 912, 1701, 1764, 1848, 3696, 3648.
(10.) 3915282 × 2079, 2268, 2541, 2772, 3024, 3276, 3528.

Rule VIII.—Contraction.

To multiply by a number the figures of which are multiples one of the other.

1°. Multiply by one of the measures in the multiplier.

2°. Multiply the product by the number indicated in the multiple of the first multiplier.

3°. Proceed thus until all the figures of the multiplier have been employed, and add the results for the required general product, always being careful to place the first figure of any given product under the extreme right-hand digit of the multiplier in use for the time being.

Illustrative Examples.—Multiply 364157 by 648192 and 36875 by 84217.

$$
\begin{array}{r l}
364157 & \\
648192 & \\
\hline
2913256000 & = 8 \times 1000 = 8000 \text{ times.} \\
233060480000 & = 8 \times 8 \times 10000 = 640000 \text{ times.} \\
69918144 & = 3 \times 64 = 192 \text{ times.} \\
\hline
236043654144 & = 648192 \text{ times.} \\
\hline\hline
\end{array}
$$

$$
\begin{array}{r l}
36875 & \\
84217 & \\
\hline
258125 & = 7 \text{ times.} \\
774375 & = 30 \times 7 = 210 \text{ times.} \\
3097500 & = 400 \times 210 = 84000 \text{ times.} \\
\hline
3105501875 & = 84217 \text{ times.} \\
\hline\hline
\end{array}
$$

(The examples are self-explanatory.)

Exercise 8.—CONTRACTION No. 1.

(1.) 3157824 × 1684, 96164, 567819, 121441728.
(2.) 2468975 × 2793, 105355, 49756, 11521296.
(3.) 9876543 × 48126, 216726, 42684, 12969108.
(4.) 2345678 × 63217, 105217, 568392, 8647212.
(5.) 6472839 × 96248, 96328, 872504, 121321584.

Each in three lines of figures.

RULE IX.

To multiply by a number consisting of unity in all places except the first, as 11115.

1°. Place the multiplier as in ordinary multiplication, multiply by the unit figure, and add in, at each multiplication, as many back figures as there are "ones" in the multiplier.

2°. When the last digit of the multiplicand has been used imagine ciphers to be prefixed—as many ciphers as there are "ones"—and add the back figures until these ciphers are exhausted.

Illustrative Example.—Multiply 361572 by 1113.

$$\begin{array}{r} 361572 \\ 1113 \\ \hline 402429636 \\ \hline \end{array}$$

The work is given below in the briefest form:—

$3 \times 2 = 6$, put it down.

$3 \times 7 + 2 = 2\underline{3}$ carry 2 : $3 \times 5 + 2 + 2 + 7 = 2\underline{6}$ carry 2 : $3 \times 1 + 2 + 2 + 7 + 5 = 1\underline{9}$ carry 1 : $3 \times 6 + 1 + 7 + 5 + 1 = 3\underline{2}$ carry 3 : $3 \times 3 + 3 + 5 + 1 + 6 = 2\underline{4}$ carry 2 : $3 \times 0 + 2 + 1 + 6 + 3 = 1\underline{2}$ carry 1 : $3 \times 0 + 1 + 6 + 3 = 1\underline{0}$ carry 1 : $3 \times 0 + 1 + 3 = 4$, put it down.

Exercise 9.—CONTRACTION No. 2.

(1.) 314567 × 115, 113, 1119, 11118.
(2.) 416753 × 117, 118, 1118, 11117.
(3.) 147635 × 116, 117, 1117, 11116.
(4.) 741536 × 119, 116, 1116, 11115.
(5.) 635147 × 118, 115, 1114, 11114.

Each in one line.

RULE X.

To multiply by a number composed entirely of the digit nine or almost entirely of nines.

1°. If the multiplier be composed altogether of nines, affix as many ciphers to the number as there are nines in the multiplier, and find the difference between this result and the original multiplicand.

2°. If the unit or ten digit of the multiplier be other than nine, affix ciphers as before, and, multiplying the original multiplicand by the requisite number, find the difference as in case 1°.

Illustrative Examples.—Multiply 54321 by 99999 and 12345 by 997.

5432100000 =	100000 times.	12345000 =	1000 times.
54321 =	1 „	37035 =	3 „
5432045679 =	99999 „	12307965 =	997 „

Exercise 10.—CONTRACTION No. 3.

(1.) 314562 × 99, 997, 9998, 99995.

(2.) 567231 × 9, 98, 993, 9989.

(3.) 219873 × 995, 991, 9988.

(4.) 675432 × 99, 995, 9998, 99987.

(5.) 981347 × 9, 98, 992, 9991.

(6.) 825968 × 997, 99988, 9999985.

RULE XI.

To multiply by 11 in the easiest way.

1°. Add the preceding figure to every digit, carrying as in ordinary addition.

Illustrative Example.—Multiply 87654321 by 11.

```
87654321
      11
964197531
```

Bring down 1 : then 1 + 2 = 3, set it down : 2+3=5 down : 3 + 4 = 7 down : 4+5=9 down : 5+6=11, down 1 and carry 1 :

1+6+7 = 14, down 4 and carry 1 : 1 + 7+8 = 16, down 6 and carry 1 : 1+8 = 9, set it down.

Exercise 11.—CONTRACTION No. 4.

(1.) 876543219 × 11.
(2.) 785634912 × 11.
(3.) 678345921 × 11.
(4.) 56789123 × 11.
(5.) 32198765 × 11.
(6.) 23917856 × 11.
(7.) 93287143 × 11.
(8.) 37692145863 × 11.
(9.) 73961254368 × 11.
(10.) 67312985436 × 11.
(11.) 13765892634 × 11.
(12.) 46329856731 × 11.
(13.) 64238965137 × 11.
(14.) 24698315634 × 11.

RULE XII.

To multiply by any number between 20 and 30.

1°. Multiply by the unit figure of the multiplier as in Rule IX. and add double the last figure of the multiplicand used to each product as it is obtained.

Illustrative Example.—Multiply 5478231 by 26.

$$\begin{array}{r}5478231\\ \underline{26}\\ \underline{\underline{142434006}}\end{array}$$

Explanation of process:

6 × 1 = 6 down : 6 × 3 + (2 × 1) = 20, down 0 and carry 2.

6 × 2 + 2 + (2 × 3) = 20, and so on to 6 × 5 + 4 (carried) + (2 × 4) = 42, down 2 and carry 4.

Lastly, 6 × 0 + 4 (carried) + (2 × 5) = 14, put it down.

Note.—This contraction may be extended to numbers between 30 and 40, even up to 50, 60, or 70, when the student will require to add 3 times, 4, 5, 6, or 7 times the back figure.

Exercise 12.—CONTRACTION No. 5.

$$\left.\begin{array}{lr}(1.) & 911822733\\ (2.) & 456789012\\ (3.) & 39876543\\ (4.) & 293847561\\ (5.) & 668877559\\ (6.) & 767868969\\ (7.) & 323535737\\ (8.) & 648759861\end{array}\right\}\times\left\{\begin{array}{l}21.\\ 22.\\ 23.\\ 24.\\ 25.\\ 26.\\ 27.\\ 28.\\ 29.\end{array}\right.$$

By the short method of doubling the last figure used, &c., by Contraction 5.

SIMPLE DIVISION.

Division is the method of finding how often one number or quantity (called the Divisor) is contained in another number or quantity (called the Dividend). The result is called the Quotient.

RULE XIII.

To divide by a number not greater than 20.

1°. Place the divisor to the left of the dividend, under which draw a line. See how often the divisor is contained in the first left-hand figure (or first two or three left-hand figures) of the dividend, and put it down under that figure (or under the second or third figure according as two or three figures have been used).

2°. Carry any overplus and prefix it mentally to the next figure of the dividend, and proceed with the division of the number thus formed as in case 1°, carrying the excess as before. Repeat the process to the end of the line, where set down also the last overplus (if any).

Illustrative Example.—Divide 112345678 by 12.

The operation is thus:

12 is not contained in 1 nor in 11, but it is contained 9 times (set it down under the third figure as it was used) in 112 with 4 over: 4 prefixed to 3 makes 43, in which 12 is contained 3 times (down) and 7 over: prefix 7 to 4 and 12 in 74 is 6 times (down) and 2 over. Thus go on to the last figure 8 to which is prefixed 11 (number carried), 12 in 118 is 9 times (down) and 10 over, which is also set down on the outside as the overplus.

12)112345678
9362139 – 10

Exercise 13.

(1.) 86324571 ÷ 2, 3, 4.
(2.) 68235417 ÷ 3, 4, 5.
(3.) 28617453 ÷ 4, 5, 6.
(4.) 82164735 ÷ 6, 7, 8.
(5.) 53746128 ÷ 7, 8, 9.
(6.) 73582164 ÷ 8, 9, 11.
(7.) 46123785 ÷ 9, 11, 12.
(8.) 32164578 ÷ 11, 12, 13.
(9.) 23618754 ÷ 12, 13, 14.
(10.) 16325748 ÷ 13, 14, 15.
(11.) 116396280 ÷ 3, 4, 5, 6, 7.
(12.) 232792560 ÷ 4, 5, 6, 7, 8.

(13.) 349188840 ÷ 5, 6, 7, 8, 9.
(14.) 465585120 ÷ 6, 7, 8, 9, 11.
(15.) 931170240 ÷ 7, 8, 9, 11, 13.
(16.) 7449361920 ÷ 8, 9, 11, 13, 14.
(17.) 29797447680 ÷ 9, 11, 13, 14, 15.
(18.) 3724680960 ÷ 11, 13, 14, 15, 17.
(19.) 14898723840 ÷ 13, 14, 15, 17, 18.
(20.) 1862340480 ÷ 14, 15, 17, 18, 19.

(21.) 5587021440 ÷ 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19.

RULE XIV.

To divide by Factors.

1°. Divide by either or any one of the factors and the result by a second factor, the second result by a third factor (if so many), and so on until all the factors have been used.

2°. To get the surplus or overplus, after the first division, multiply each overplus as it is obtained, by every preceding divisor save its own, and add the preceding overplus (if any) to the product.

Illustrative Example.—Divide 5130656 by 420, using 3, 4, 7, 5.

$$\begin{array}{r|r}
3 & 5130656 \\ \hline
4 & 1710218 - 2 \\ \hline
7 & 427554 - 8 \\ \hline
5 & 61079 - 20 \\ \hline
 & 12215 - 356
\end{array}$$

First overplus being 2 is so set down.

Second overplus is 2 also, and real overplus = 2 × 3 + 2 = 8 (set down).

Third overplus is 1, and real third overplus = 1 × 4 × 3 + 8 = 20 (set down).

Fourth overplus is 4, and real overplus = 4 × 7 × 4 × 3 + 20 = 356 (set down).

Exercise 14.—FACTORIAL DIVISION.

(1.) 191817161514 ÷ 2, 2, 2; 3, 3, 3; 4, 4, 4.
(2.) 292827262524 ÷ 5, 5; 6, 6; 2, 2, 2, 2; 3, 3, 3, 3.
(3.) 393837363534 ÷ 4, 4, 4, 4; 5, 5, 5, 5; 6, 6, 6, 6.
(4.) 494847464544 ÷ 7, 7, 7; 8, 8, 8; 9, 9, 9.
(5.) 595857565554 ÷ 2, 3, 4, 5, 6; 3, 4, 5, 6, 7.
(6.) 69686765646 ÷ 5, 6, 7, 8; 9, 6, 2, 3; 4, 5, 6, 7.

(7.) 79787675747 ÷ 2, 3, 4, 5, 6, 7; 3, 4, 5, 6, 7, 8.
(8.) 89878685848 ÷ 9, 9, 9, 9, 9; 11, 11, 11, 11, 11.
(9.) 91929394959697 ÷ 2, 3, 4, 5, 6, 7, 8, 9, 11, 12.
(10.) 81828384858687 ÷ 2, 3, 4, 5, 6, 7, 8, 9, 11, 12.

RULE XV.

To divide by any number higher than 20.

1°. Place the divisor to the left of the dividend and draw a vertical line between them, also a horizontal line below them.

2°. Proceed to divide as in short division, placing the figure of the quotient under the divisor and writing the increment or overplus (obtained by complementary addition) under the various figures being divided.

3°. Bring down the next figure, draw a line under the new partial dividend, and proceed as before, repeating the process until all the figures of the dividend have been brought down.

Illustrative Example.—Divide 1234567 by 151.

The work is carried on as follows: 151 into 1 no times; into 12 no times; into 123 no times; into 1234 8 times (set down); then $8 \times 1 = 8$ and 6 (down) are 14 carry 1; $8 \times 5 + 1 = 41$ and 2 (down) are 43 carry 4; $8 \times 1 + 4 = 12$ and 0 are 12.

$$
\begin{array}{r|l}
\underline{151} & \underline{1234567} \\
\text{Ans. } 8175 & \quad \underline{265} \\
 & \quad \underline{1146} \\
 & \qquad \underline{897} \\
 & \qquad 142 = \text{Overplus.}
\end{array}
$$

Bring down 5 and draw line: Divisor is contained 1 time (down). Then 1 and 4 (down) = 5; 5 and 1 (down) = 6; 1 and 1 (down) = 2; bring down 6 and draw line; it will go 7 times, set it down.

Then $7 \times 1 = 7$ and 9 (down) = 16 carry 1;
$7 \times 5 + 1 = 36$ and 8 (down) = 44 carry 4;
$7 \times 1 + 4 = 11$ and $0 = 11$. Bring down 7, draw line, and the next quotient figure is 5.

Then $5 \times 1 = 5$ and 2 (down) = 7;
$5 \times 5 = 25$ and 4 (down) = 29 carry 2;
$5 \times 1 + 2 = 7$ and 1 (down) = 8.

Note.—For the first time (it is believed) is this system brought before the public and advocated as the best, the shortest, and the easiest method of performing Long Division. Once understood its beauty and brevity are fully appreciated, and to those who undertake the study of the science of numbers as contained in the present treatise, no difficulty be experienced in completely mastering it. Indeed, it is more easily grasped by those familiar with the prece chapters, and who have worked from the very beginning, i is the tedious and ordinary Rule of Long Division as gene taught. The principle of Incremental Addition is not ne them, and there is therefore nothing to interfere with an mediate apprehension of the whole rule. The advan offered by this innovation in all subsequent processes ca fail to be perceived by the most casual reader, and will tainly be enjoyed by the persevering student.

Exercise 15.

(1.) 570021 ÷ 77.
(2.) 62501 ÷ 250.
(3.) 10897080 ÷ 120.
(4.) 2239605 ÷ 317.
(5.) 537152 ÷ 763.
(6.) 774656 ÷ 256.
(7.) 795495 ÷ 293.
(8.) 491238 ÷ 827.
(9.) 275487 ÷ 736.
(10.) 732540408423 ÷ 273.
(11.) 973021546019 ÷ 397.
(12.) 99998001 ÷ 9999.
(13.) 539216473 ÷ 479.
(14.) 348753392 ÷ 688.
(15.) 337103025 ÷ 861.
(16.) 34024375 ÷ 4375.
(17.) 501000500 ÷ 3850.
(18.) 10814220 ÷ 876.
(19.) 2490201 ÷ 4089.
(20.) 3452164 ÷ 1858.
(21.) 5332114 ÷ 1234.
(22.) 5332114 ÷ 4321.
(23.) 4682135 ÷ 1946.
(24.) 56831974 ÷ 3278.
(25.) 16122344 ÷ 536.
(26.) 15580656 ÷ 6552.
(27.) 19094867 ÷ 4009.
(28.) 7855568 ÷ 4173.
(29.) 12345678 ÷ 1234.
(30.) 87654321 ÷ 8765.
(31.) 514488703 ÷ 567.

RULE XVI.

To divide by 5.

1°. Double the dividend and take half the unit figure overplus.

Illustrative Example.—Divide 8123457 by 5.

Explanation:—

By doubling and cutting off the right-hand figure we take one-tenth of twice the dividend, and by taking half the *unit figure* cut off we obtain the real overplus.

$$\begin{array}{r} 8123457 \\ 2 \\ \hline 1624691(4) \\ \hline \hline \end{array} \text{ 2 overplus.}$$

Exercise 16.

(1.) 123456789
(2.) 214365987
(3.) 412563798 ÷ 5.
(4.) 897365214
(5.) 893756124

(6.) 1102203304405
(7.) 9088007060054
(8.) 9182007765432 ÷ 5.
(9.) 7231486246519
(10.) 837363534321

RULE XVII.

To divide any number by 25.

1°. Multiply the dividend by 4, and take one-fourth of the last 2 right-hand figures for the true overplus.

Illustrative Example.—Divide 8125674 by 25.

Explanation:— 8125674
25 is one-fourth of 100. 4
See Rule XVI. for principle. 325026(96) 24 true overplus.

Exercise 17.

(1.) 315721489
(2.) 137512948
(3.) 731215894 ÷ 25.
(4.) 172541983
(5.) 572138941

(6.) 987654321
(7.) 896745123
(8.) 789123456 ÷ 25.
(9.) 871932654
(10.) 178239465

RULE XVIII.

To divide any number by 125.

1°. Multiply the dividend by 8.

2°. Take an eighth of the 3 right-hand figures for the overplus. The other figures to the left form the quotient.

Illustrative Example.—Divide 361452 by 125.

361452
(The working is self-explanatory.) 8
See Rule XVI. for principle. 2891(616)
Ans. is 2891 & 77 overplus.

Exercise 18.

(1.) 9988776655
(2.) 9897878643
(3.) 3468972314 ÷ 125.
(4.) 8643413279
(5.) 5163246814

(6.) 123987654321
(7.) 462572183645
(8.) 526438127546 ÷ 125.
(9.) 654721834627
(10.) 12746572643

RULE XIX.

To divide by 35, 45, &c., up to 95.

1°. Multiply the dividend by 2, divide by twice the divisor, and halve the excess for the true overplus.

Illustrative Example.—Divide 514372 by 55.

$$\begin{array}{rl} & 514372 \\ & \underline{\qquad\quad 2} \\ 11\cancel{0}) & \overline{102874(4)} \\ & \underline{9352-12} \quad \text{Ans.} \end{array}$$

Exercise 19.

(1.) 123456789 ÷ 35.
(2.) 214365978 ÷ 45.
(3.) 326549871 ÷ 55.
(4.) 312654897 ÷ 65.
(5.) 432198765 ÷ 75.
(6.) 413297856 ÷ 85.
(7.) 658792314 ÷ 95.
(8.) 567829413 ÷ 45, 85.
(9.) 856297431 ÷ 65, 95.
(10.) 785641923 ÷ 75, 55.

RULE XX.

To divide by a divisor made up of nines only.

1°. Divide the number by 1 with as many ciphers annexed as there are nines in the divisor.

2°. Divide the quotient thus obtained by the same number, and continue the division as long as possible.

3°. Add all these quotients and the dividend together as well as the overpluses. Add also to the sum of the overpluses whatever has been carried from their sum to the quotients. This will give the true overplus.

Illustrative Example.—Divide 123456789876 by 9999.

Explanation:—As there are 4 nines in the divisor we divide the given number by 10000, drawing a vertical line to separate the quotients from the overpluses. In adding, 1 is carried from sum of overpluses to the sum of the quotients, we therefore increase the sum of the overpluses *by that number.*

	Over-pluses.	
12345678	9876	
1234	5678	
	1234	
Ans. 12346913	6788	}
	1	
True overplus	6789	

Exercise 20.

$$\left.\begin{array}{rl}
(1.) & 9807605403201 \\
(2.) & 9087065043020 \\
(3.) & 9870065400302 \\
(4.) & 9080706050403 \\
(5.) & 2030450670809 \\
(6.) & 5700630089002 \\
(7.) & 3504672140057 \\
(8.) & 8903210004562 \\
(9.) & 5140037800625 \\
(10.) & 7500840096384 \\
(11.) & 2357858392461 \\
(12.) & 625841524379 \\
(13.) & 61894583214 \\
(14.) & 555444333221 \\
(15.) & 448899666777
\end{array}\right\} \div \left\{\begin{array}{l}
999. \\
9999. \\
99999. \\
999999. \\
9999999.
\end{array}\right.$$

Rule XXI.

To divide by 75, 175, 225, or 275.

1°. Multiply the dividend by 4 and divide by 300, 700, 900, 1100, taking one-fourth of the excess for the true over-us.

Illustrative Examples.—Divide 4567654 by 75, 175, 225, d 275.

$$\begin{array}{r} 4567654 \\ 4 \\ \hline 3\cancel{00})\,182706(16) \\ \hline 60902 - 4 \end{array} \qquad \begin{array}{r} 4567654 \\ 4 \\ \hline 7\cancel{00})\,182706(16) \\ \hline 26100 - 154 \end{array} \qquad \begin{array}{r} 4567654 \\ 4 \\ \hline 9\cancel{00})\,182706(16) \\ \hline 20300 - 154 \end{array}$$

$$\begin{array}{r} 4567654 \\ 4 \\ \hline 11\cancel{00})\,182706(16) \\ \hline 16609 - 179 \end{array}$$

(No explanation is necessary.)

Exercise 21.

$$\left.\begin{array}{lr}(1.) & 1020304050607\\ (2.) & 2014036050706\\ (3.) & 302503060425\\ (4.) & 632157892468\\ (5.) & 543219876543\\ (6.) & 987654321234\end{array}\right\}\div 75,\ 175,\ 225,\ 275.$$

CONTRACTED MULTIPLICATION.

Rule XXII.

To multiply any number by 5.

1°. Add a cipher to the multiplicand and divide by 2.

Illustrative Example.—Multiply 8319624 by 5.

(Explanation unnecessary.)

$$\begin{array}{r}2\underline{)83196240}\\ \underline{\underline{41598120}}\end{array}$$

Exercise 22.

$$\left.\begin{array}{lr}(1.) & 213546879\\ (2.) & 53129786\\ (3.) & 35217968\\ (4.) & 12538697\\ (5.) & 68792153\\ (6.) & 86971235\end{array}\right\}\times 5. \qquad \left.\begin{array}{lr}(7.) & 918273645\\ (8.) & 218954637\\ (9.) & 129845736\\ (10.) & 637592148\\ (11.) & 573684129\\ (12.) & 756348921\end{array}\right\}\times 5.$$

Rule XXIII.

To multiply any number by 25.

1°. Add two ciphers to the multiplicand and divide by 4

Illustrative Example.—Multiply 78912345 by 25.

$$\begin{array}{r}4\underline{)7891234500}\\ \underline{\underline{1972808625}}\end{array}$$

Exercise 23.

$$\left.\begin{array}{lr}(1.) & 987654321\\ (2.) & 896712345\\ (3.) & 698217543\\ (4.) & 962834715\\ (5.) & 517438296\end{array}\right\}\times 25. \qquad \left.\begin{array}{lr}(6.) & 830165081\\ (7.) & 752103297\\ (8.) & 530247908\\ (9.) & 621032541\\ (10.) & 105430625\end{array}\right\}\times 25.$$

RULE XXIV.

To multiply any number by 35, 45, 55, &c.

1°. Multiply by twice the multiplier and take half the product.

Illustrative Example.—Multiply 841562 by 35, 45, and 55.

841562	841562	841562
70	90	110
2)58909340	2)75740580	2)92571820
29454670	37870290	46285910

Exercise 24.

(1.) 88776655	×	35.	(4.) 123456789	×	35.
(2.) 78912345		45.	(5.) 321987654		45.
(3.) 21457894		55.	(6.) 789123456		55.

RULE XXV.

To multiply any number by 75.

1°. Affix two ciphers to the multiplicand, divide this number by 4, and find the difference between the two quantities by incremental addition.

Illustrative Example.—Multiply 136247 by 75.

(Explanation unnecessary.)

4)13624700 = 100 times.
3406175 = 25 „
10218525 = 75 „

Exercise 25.

(1.) 987654321	× 75.	(6.) 830165081	× 75.
(2.) 896712345		(7.) 752103297	
(3.) 698217543		(8.) 530247908	
(4.) 962834715		(9.) 621032541	
(5.) 517438296		(10.) 105430625	

RULE XXVI.

To multiply any number by 125.

1°. Affix three ciphers to the multiplicand and divide by 8.

Illustrative Example.—Multiply 9876543 by 125.

8)9876543000
(125 is one-eighth of 1000.) 1234567875

Exercise 26.

(1.) 88776655 × 125.
(2.) 78912345 × 125.
(3.) 32198765 × 125.
(4.) 123987564 × 125.
(5.) 893214657 × 125.
(6.) 756412398 × 125.

Rule XXVII.

To multiply any number by 375.

1°. Multiply first as in Rule XXVI. by 125, and mult the result by 3.

Illustrative Example.—Multiply 841637 by 375.

8)841637000
105204625
(Reason for process is obvious.) 3
315613875

Exercise 27.

(1.) 19283746 × 375.
(2.) 91827364 × 375.
(3.) 28194637 × 375.
(4.) 32560147 × 3
(5.) 23651074 × 3
(6.) 47630125 × 3

Rule XXVIII.

To multiply any number by 875.

1°. Affix three ciphers to the multiplicand; divide t ber by 8, and find the difference between the tw by incremental addition.

Illustrative Example.—Multiply 51643 by 875.

8)51643000 = 1000 times.
6455375 = 125 „
45187625 = 875 „

Exercise 28.

$$\left.\begin{array}{ll}(1.) & 36715241\\ (2.) & 63174256\\ (3.) & 13624665\\ (4.) & 26315479\\ (5.) & 81456783\end{array}\right\}\times 875. \qquad \left.\begin{array}{ll}(6.) & 1234567\\ (7.) & 7654321\\ (8.) & 3217654\\ (9.) & 4567123\\ (10.) & 6712345\end{array}\right\}\times 875.$$

Rule XXIX.

To multiply a number by any tridigit of the form 264, or 143, where the tens digit or figure equals the sum of the other two digits.

1°. Multiply the quantity by the number formed by taking the unit digit and prefixing the hundred digit.

2°. Repeat this product under itself, only one place to the left, and add.

Illustrative Example.—Multiply 415206 by 154.

(The work explains itself.)

$$\begin{array}{rl} 415206 & \\ 154 & \\ \hline 5812884 & = 14 \text{ times.}\\ 5812884 & = 140 \;\;\text{"}\\ \hline 63941724 & = 154 \;\;\text{"}\\ \hline\hline \end{array}$$

Exercise 29.

$$\left.\begin{array}{ll}(1.) & 756341\\ (2.) & 573614\\ (3.) & 375416\\ (4.) & 614573\\ (5.) & 165437\end{array}\right\}\times\left\{\begin{array}{l}121.\\ 132.\\ 143.\\ 275.\end{array}\right. \qquad \left.\begin{array}{ll}(6.) & 543219\\ (7.) & 452391\\ (8.) & 254193\\ (9.) & 391452\\ (10.) & 934125\end{array}\right\}\times\left\{\begin{array}{l}121.\\ 132.\\ 165.\\ 275.\end{array}\right.$$

Rule XXX.

To multiply a number by 175.

1°. Multiply by 700 and divide the product by 4.

Illustrative Example.—Multiply 859776 by 175.

(Explanation unnecessary.)

$$\begin{array}{r} 859776\\ 700\\ \hline 4)\underline{601843200}\\ 150460800\\ \hline\hline \end{array}$$

Rule XXXI.

To multiply a number by 275.
1°. Multiply by 1100 and divide by 4.

Illustrative Example.—Multiply 836975 by 275.

$$\begin{array}{r} 836975 \\ 1100 \\ \hline 4)\,920672500 \\ \hline 230168125 \\ \hline\hline \end{array}$$

Exercises 30 and 31.

$$\left.\begin{array}{l} (1.)\ 86543268 \\ (2.)\ 12345678 \\ (3.)\ 98765432 \\ (4.)\ 19876543 \\ (5.)\ 21987654 \end{array}\right\} \times 175 \text{ and } 275 \left\{\begin{array}{l} (6.)\ 998877665. \\ (7.)\ 989876756. \\ (8.)\ 898967657. \\ (9.)\ 68796598. \\ (10.)\ 78656989. \end{array}\right.$$

PROOFS OF DIVISIBILITY.

It is of the highest importance that students should be able to see at a glance whether any number is divisible without remainder by any of the numbers 2, 3, 4, 5, 6, 8, 9, 11, or 12 (of course if a number ends in 0 it is divisible by 10). The following proofs are easily remembered, and the learner should be frequently exercised in the practice of discovering such factors by inspection, as expertness in this work will be a valuable acquisition in all fractional processes.

Rule XXXII.

To ascertain whether a number is divisible by 2, 3, 4, 5, 6, 8, 9, 10, 11, or 12.

1°. A number is divisible by 2 if the unit figure be even or 0; by 3 if the sum of its digits is divisible by 3; by 4 if the last two figures be divisible by 4; by 5 if the unit figure be 0 or 5; by 6 if divisible by 2 and 3; by 8 if the last 3 figures are divisible by 8; by 9 if the sum of its digits is divisible by 9;

by 10 if the unit figure be 0; by 11 if the sums of its alternate digits are equal, or if they differ by any multiple of 11; by 12 if divisible by 3 and 4.

Illustrative Example.—Determine whether 7920 be divisible by 2, 3, 4, 5, 6, 8, 9, 10, 11, or 12.

It is divisible by 2 because unit figure is 0.
" " 3 " sum of its digits 7, 9, 2, 0 is divisible by 3.
" " 4 " 20 is divisible by 4.
" " 5 " unit figure is 0.
" " 6 " divisible by 2 and 3.
" " 8 " 920 is divisible by 8.
" " 9 " $(7+9+2+0)$ or sum of digits is divisible by 9.
" " 10 " unit figure is 0.
" " 11 " $(7+2)=(9+0)$ sums of alternate digits being equal.
" " 12 " divisible by 3 and 4.

Note.—1. Every prime number must have its unit figure 1, 3, 7, or 9.

2. Every square number must have its last significant figure 1, 4, 5, 6, or 9.

3. Any prime number save 2 and 5 is a measure of as many **nines** (less 1) as indicated by the number.

4. Any prime number save 2, 3, and 5 is a measure of as many ones (less 1) as indicated by the prime itself.

5. Every number of 4 figures of the form 8008 (*i.e.* having the extreme digits the same and the interior digits ciphers) is divisible by 7, 11, and 13.

Exercise 32.

I. Determine by which of the numbers 2, 3, 4, 5, 6, 8, 9, 10, 11, or 12 each of the following is divisible.

(1.) 4536.
(2.) 4608.
(3.) 4704.
(4.) 4725.
(5.) 4752.
(6.) 4802.
(7.) 4851.
(8.) 4928.
(9.) 5488.
(10.) 5544.
(11.) 5625.
(12.) 5632.
(13.) 5775.
(14.) 5808.
(15.) 5832.
(16.) 5929.
(17.) 6655.
(18.) 6776.
(19.) 6804.
(20.) 6860.
(21.) 6875.
(22.) 6912.
(23.) 7623.
(24.) 7875.

(25.) 8019.
(26.) 8085.
(27.) 8505.
(28.) 8575.
(29.) 9075.
(30.) 9261.
(31.) 9317.
(32.) 9801.
(33.) 7203.
(34.) 6561.
(35.) 6237.
(36.) 5103.
(37.) 3993.
(38.) 3969.
(39.) 3773.
(40.) 3267.

II. Resolve into their prime factors:—

(1.) 3125.
(2.) 3234.
(3.) 3375.
(4.) 4032.
(5.) 5082.
(6.) 6048.
(7.) 7056.
(8.) 8019.
(9.) 9072.
(10.) 8192.
(11.) 7128.
(12.) 6125.
(13.) 5103.
(14.) 4116.
(15.) 3993.
(16.) 4928.
(17.) 5929.
(18.) 6912.
(19.) 7986.
(20.) 8748.
(21.) 9856.
(22.) 9702.
(23.) 8748.
(24.) 7776.
(25.) 6776.
(26.) 5775.
(27.) 4752.
(28.) 3773.
(29.) 2772.
(30.) 9801.

REDUCTION.

Reduction is the method which enables us to express a mi
or compound quantity of several denominations in terms of
one required denomination, and conversely. It may be divi
into Simple Reduction—(Ascending *or* Descending), and C
plex—(Ascending *and* Descending). Simple Reduction o
will be investigated at this stage, as the consideration of C
plex Reduction is more profitably taken up when the subj
of Fractions has been studied.

RULE XXXIII.

To represent a mixed or compound quantity of several
nominations in terms of any one required denominat
(Descending Reduction).

1°. Multiply the number of the highest denomination in
given quantity by that number of the next lower denomi
tion which makes one of the highest denomination, adding
to the product any units of the lower denomination th
may be in the quantity.

2°. Multiply this result by the number of the *next* lo denomination, which makes one of the denomination just obtained, adding in as before. Proceed in this manner until the lowest or required denomination is obtained.

Illustrative Examples.—(1.) Reduce £1987, 17*s.* 10¾*d.* to farthings.

$$\begin{array}{rl}
\pounds \quad s. \quad d. & \\
1987 \quad 17 \quad 10\tfrac{3}{4} & \\
20 & \\
\hline
39757 & = \text{number of shillings in } \pounds1987,\ 17s.\ 0d. \\
12 & \\
\hline
477094 & = \text{number of pence in } \pounds1987,\ 17s.\ 10d. \\
4 & \\
\hline
1908379 & = \text{number of farthings in } \pounds1987,\ 17s.\ 10\tfrac{3}{4}d. \\
\hline\hline
\end{array}$$

Or more briefly thus, without entering the multipliers.

$$\begin{array}{rll}
\pounds & s. & d. \\
1987 & 17 & 10\tfrac{3}{4} \\
\hline
39757 & & \\
\hline
477094 & & \\
\hline
1908379 & & \\
\hline\hline
\end{array}$$

(2.) Reduce 3 tons 18 cwts. 2 qrs. 21 lbs. to lbs.

$$\begin{array}{rl}
\text{tons. cwts. qrs. lbs.} & \\
3 \quad 18 \quad 2 \quad 21 & \\
20 & \\
\hline
78 & = \text{number of cwts. in 3 tons 18 cwts.} \\
4 & \\
\hline
314 & = \text{number of qrs. in 3 tons 18 cwts. 2 qrs.} \\
\left.\begin{array}{r} 4 \\ \hline 1256 \\ 7 \end{array}\right\} & 4 \times 7 = 28. \\
\hline
8813 & = \text{number of lbs. in 3 tons 18 cwts. 2 qrs. 21 lbs.} \\
\hline\hline
\end{array}$$

The multipliers are generally employed written, but it will be much preferable for the scholar at the earliest possible moment to discard their written use and employ them mentally.

Any one having worked through the preceding examples should be fully competent to dispense with written multipliers.

Exercise 33.

Reduce:—

(1.) £36, 3*s.* 4½*d.* to halfpence.
(2.) £92, 11*s.* 8*d.* to farthings.
(3.) £201, 15*s.* 4½*d.* to halfpence.
(4.) £819, 14*s.* 3½*d.* to farthings.
(5.) £3, 17*s.* 6*d.* "
(6.) £147, 17*s.* 6½*d.* "
(7.) £109, 11*s.* 10½*d.* "
(8.) £553, 0*s.* 11¾*d.* "
(9.) £807, 19*s.* 6¼*d.* "
(10.) £459, 8*s.* 3¾*d.* "
(11.) £8013, 6*s.* 10*d.* to twopences.
(12.) £999, 18*s.* 9*d.* to threepences.
(13.) £1414, 14*s.* 4*d.* to fourpences.
(14.) £932, 17*s.* 6*d.* to sixpences.
(15.) £1507, 12*s.* 6*d.* to half-crowns.
(16.) 13 yds. 7 ft. 19 in. to square inches.
(17.) 1 week to seconds.
(18.) 20 tons 15 cwts. 1 oz. to ounces.
(19.) 1 lb. 2 oz. 4 drs. 2 scr. 7 grs. to grains.
(20.) 3 weeks 6 days 10 hrs. 13 sec. to seconds.
(21.) 6 weeks 2 days 18 hrs. 15 min. 19 sec. to seconds.
(22.) 100 years to seconds.
(23.) 5 cwts. 3 qrs. 17 lbs. 10 oz. to ounces.
(24.) 3 yds. 3 nls. 1½ in. to inches.
(25.) 2 miles 6 fur. 4 yds. to feet.
(26.) 5 lbs. 3 oz. 1 scr. to grains.
(27.) 1 cu. yd. 24 cu. ft. 760 cu. in. to cubic inches.
(28.) 1 cwt. 1 qr. 2 lbs. 11$\frac{3}{7}$ oz. to grains (Troy).
(29.) 3 roods 5 poles 23 yds. 6 ft. 108 in. to inches.
(30.) 75 ac. 2 roods 32 poles to yards.
(31.) 1 solar year to seconds.
(32.) 1 leap year to seconds.
(33.) 35 days 8 hrs. 48 min. 29 sec. to seconds.
(34.) 42 weeks 8 hrs. 15 min. 5 sec. to seconds.
(35.) 14 lbs. 11 oz. 11 grs. to grains.
(36.) 11 miles 6 poles 4 yds. to feet.
(37.) 375 cwts. 2 qrs. 27 lbs. to ounces.
(38.) £527, 16*s.* 8½*d.* to farthings.
(39.) 47 cwts. 1 qr. 16 lbs. 2 oz. to drams.
(40.) 13 lbs. 7 oz. 16 grs. to grains.
(41.) *£9, 19s.* 10¾*d.* to farthings.

(42.) 54 cwts. 3 qrs. 18 lbs. 14 oz. to drams.
(43.) 17 lbs. 6 oz. 12 dwts. 7 grs. to grains.
(44.) 18 miles 6 fur. 12 poles 2 yds. to feet.
(45.) 496 sq. yds. 2 sq. ft. to inches.
(46.) 13 yds. 7 ft. 19 in. to square inches.
(47.) 3 weeks 4 days 5 hrs. 54 min. to seconds.
(48.) 2 miles 1 fur. 12 poles 1 ft. 8 in. to inches.
(49.) 15 lbs. 10 oz. 14 grs. to grains (Troy).
(50.) 17 lbs. 3 oz. 7 dwts. to grains.
(51.) 3 ac. 20 roods 12 sq. yds. 7 ft. to square feet.
(52.) 34 lbs. 10 oz. 12 dwts. 16 grs. to grains.
(53.) 159 quarters of corn to quarts.
(54.) 42 miles 3 fur. 23 poles 3 yds. to inches.
(55.) 13 miles 5 fur. 9 poles 3 yds. to inches.
(56.) 16 tons 4 cwts. 3 qrs. 15 lbs. 13 oz. to ounces.
(57.) 1 ton 4 cwts. 3 qrs. 2 lbs. 3 oz. to ounces.
(58.) 3 tons 9 cwts. 2 qrs. 4 lbs. 6 oz. to ounces.
(59.) 12 miles 5 fur. 13 poles to inches.
(60.) 18 tons 17 cwts. 2 qrs. 1 lb. to pounds.
(61.) 42 cwts. 3 qrs. 17 lbs. 6 oz. to ounces.
(62.) 15 miles 2 fur. 36 poles 2 yds. to feet.
(63.) 15 guineas to farthings.
(64.) 18 miles 5 fur. 30 poles 2 yds. 2 ft. to inches.

RULE XXXIV.

To reduce cwts., qrs., and lbs. to lbs. in the shortest possible way.

1°. Put down the number of cwts. with two ciphers annexed.

2°. Add to this result twelve times the number of cwts., ncreased by the number of lbs. in the qrs. and lbs. of the given quantity, and the sum will be the required number of lbs.

Illustrative Example.—Reduce 2 tons 10 cwts. 3 qrs. 16 lbs. to lbs.

The question is 50 cwts. 3 qrs. 16 lbs. 3 qrs. 16 lbs. = 100 lbs.

$$\begin{array}{r}5000\\700\\\hline 5700\\\hline\end{array}$$

Exercise 34.

Reduce the following quantities to lbs. by the contracted rule:—

(1.) 2 cwts. 3 qrs. 6 lbs.
(2.) 3 „ 2 „ 14 „
(3.) 4 „ 1 „ 21 „
(4.) 5 „ 0 „ 25 „
(5.) 6 „ 2 „ 23 „
(6.) 7 „ 3 „ 22 „
(7.) 8 „ 1 „ 20 „
(8.) 9 „ 2 „ 19 „
(9.) 10 „ 3 „ 18 „
(10.) 11 „ 3 „ 17 „
(11.) 213 cwts. 3 qrs. 5 lbs.
(12.) 25 „ 2 „ 16 „
(13.) 73 „ 3 „ 15 „
(14.) 841 „ 2 „ 10 „
(15.) 96 „ 1 „ 9 „
(16.) 2 tons 15 cwts. 3 qrs. 16 lbs.
(17.) 5 „ 16 „ 2 „ 18 „
(18.) 7 „ 4 „ 1 „ 20 „
(19.) 9 „ 3 „ 0 „ 25 „
(20.) 11 „ 19 „ 0 „ 27 „

Rule XXXV.

To express any number of a given denomination in terms of a higher denomination (Ascending Reduction).

1°. Divide the given quantity by that number of the given denomination which expresses one of the next higher denomination; repeat this process on the quotient just obtained, and so on to the required denomination.

Illustrative Example.—Reduce 12345678 farthings to pounds.

4) 12345678
12) 3086419 – ½
20) 257201 – 7½
£12860 – 1 – 7½

Exercise 35.

(1.) 4037 halfpence to pounds, &c.
(2.) 91,200 guineas to pounds.
(3.) 350,721,689 farthings to pounds.
(4.) 157,813,246 „ „
(5.) 918,273,645 „ „
(6.) 818,283,848 „ „
(7.) 9,897,969,594 „ „
(8.) 325,147,867 „ „
(9.) 1,400,320,081 „ „

(10.) 1,213,141,516 farthings to guineas.
(11.) 19,181,716,151 „ „
(12.) 2,123,242,526 „ „
(13.) 29,282,726,252 „ „
(14.) 3,938,373,635 „ „
(15.) 90,000,000,000 „ „
(16.) „ farthings to pounds.
(17.) „ farthings to crowns.
(18.) „ farthings to half-guineas.
(19.) „ farthings to moidores.
(20.) „ pence to moidores.
(21.) „ pence to half-guineas.
(22.) „ pence to crowns.
(23.) „ pence to guineas.
(24.) „ pence to pounds.
(25.) „ Troy grains to pounds (Troy).
(26.) „ Troy grains to pounds (Apoth.).
(27.) „ Troy grains to tons (Avoir.).
(28.) „ inches to furlongs.
(29.) „ inches to miles.
(30.) „ inches to leagues.
(31.) „ square inches to acres.
(32.) „ square inches to square miles.
(33.) 527,895 inches to poles (long).
(34.) 483,850 cubic inches to yards.
(35.) 9,367,875 inches to miles.
(36.) 29,561,728 ounces (Avoir.) to tons, &c.
(37.) 100,000,000 inches to miles.
(38.) 80,307 ounces to cwts.
(39.) 10,729 lbs. to tons.
(40.) 11,495 square yards to acres.
(41.) 7525 grains to lbs. (Troy).
(42.) 1,000,000 grains of gold to lbs., &c.
(43.) 2,350,080 grains to lbs. (Troy).
(44.) 43,970 ounces to tons.
(45.) 3,744,576 inches to miles.
(46.) 36,000,000,000 lbs. to tons.
(47.) „ ounces to tons.

(48.) 36,000,000,000 drams to tons.
(49.) ,, seconds to days.
(50.) ,, minutes to years (365 days).
(51.) ,, cub. inches to cub. yards.
(52.) ,, gills to loads.
(53.) 6,174,581,236 farthings to pounds.
(54.) ,, Troy grains to pounds.
(55.) ,, Apoth. grains to pounds.
(56.) ,, drams to tons.
(57.) ,, lbs. to packs (wool).
(58.) ,, inches to ells (cloth).
(59.) ,, inches to leagues.
(60.) ,, square inches to square miles.
(61.) ,, gills to lasts (dry).
(62.) ,, pints to barrels (ale).
(63.) ,, seconds to years (365 days).
(64.) ,, gills to tuns (wine).
(65.) ,, farthings to guineas.

COMPOUND ADDITION.

Compound Addition is the method of finding one qua which is equal to two or more mixed or compound quan taken together.

RULE XXXVI.

To find the sum of two or more mixed or compound quant

1°. Place the quantities under each other, like denomina in the same column.

2°. Find the sum of the right-hand column and divide as many of that denomination as make one of the next hi

3°. Put down the excess (if any) under the column added and carry the quotient to the next column, which be added in the same way as the first.

4°. Proceed similarly with all the other columns.

Illustrative Example.—Add together £4, 17*s.* 8¾*d.*, £31, 10*s.* 11½*d.*, £514, 6*s.* 4¼*d.*, £19, 19*s.* 11¾*d.*

Explanation:—The farthings added up come to 9; divide by 4; 2 times and 1 farthing over (put down) and carry the 2; pence come to 36; divide by 12 (or use the pence table) and we get 3 with nothing over; shillings = 55 or £2, 15*s.*, put down 15 and carry 2 to the pounds, which are added in the usual manner.

£	*s.*	*d.*
4	17	8¾
31	10	11½
514	6	4¼
19	19	11¾
570	15	0¼

Exercise 36.

(1.)	£	*s.*	*d.*
	413	18	9
	129	5	2½
	93	17	4¾
	203	1	11¼
	68	11	10¼
	121	0	1

(2.)	£	*s.*	*d.*
	2187	16	9
	634	17	6½
	4021	3	4¼
	113	5	2½
	1935	9	1¼
	923	13	11½

(3.)	£	*s.*	*d.*
	7296	14	8¾
	417	9	7½
	3246	17	4¼
	29	8	9½
	1877	3	11
	824	19	3¾

(4.)	£	*s.*	*d.*
	71	3	4¼
	0	19	8½
	2	0	3
	1	8	0¾
	284	15	5½

(5.)	£	*s.*	*d.*
	491	17	7½
	34	5	9
	1058	18	10¼
	97	1	11¼
	0	7	4¾

(6.)	£	*s.*	*d.*
	51	13	7¾
	0	18	0¼
	270	0	0
	1235	16	5
	189	0	9½

(7.)	£	*s.*	*d.*
	2750	3	11¾
	106	18	1½
	0	3	4¼
	26	3	0½
	24	4	1¼

(8.)	£	*s.*	*d.*
	201	3	5½
	18	0	9¾
	178	6	11¼
	125	17	1½
	574	4	0
	13	19	7¼

(9.)	£	*s.*	*d.*
	200	13	2½
	23	5	1¾
	195	9	3½
	8	10	0¼
	127	2	5

(10.)	£	*s.*	*d.*
	472	11	4½
	321	7	8¼
	541	9	6¾

(11.)	£	*s.*	*d.*
	1047	16	4¾
	1	0	9½
	0	14	8¼
	62	0	1¼

(12.)	£	*s.*	*d.*
	16	11	6¼
	57	15	9½
	25	12	8¼

(13.) £	s.	d.
98	10	10½
293	15	7¾
51	17	9¾

(14.) £	s.	d.
16	17	8¼
202	15	6½
77	17	9
35	12	3¾

(15.) £	s.	d.
213	5	11
67	14	2¼
5008	6	8
389	7	3¾
21	1	6
855	11	8½
1234	18	9¾

(16.) £	s.	d.
314	17	10½
8105	2	3¾
1725	19	11¼
7384	10	4½
257	0	0¾
90	8	8½

(17.) lbs.	oz.	dwts.	grs.
161	10	18	21
33	3	13	23
842	8	8	12
373	11	19	20

(18.) lbs.	oz.	drs.	scr.	grs.
31	6	4	2	16
25	9	7	1	18
44	4	4	2	14
99	11	6	2	19

(19.) tons	cwts.	qrs.	lbs.	oz.	drs.
16	18	3	27	11	15
238	19	2	26	15	14
41	10	1	25	12	15
999	15	3	24	14	14
88	8	3	23	13	13

(20.) cub. yds.	cub. ft.	cub. in.
1368	26	1632
4572	22	1289
8962	18	998
9384	25	1584
7777	24	1714

(21.) lea.	miles	fur.	po.	yds.	ft.	in.
163	2	7	35	4½	2	11
78	2	6	27	3½	1	10
92	1	7	38	2½	2	11
41	2	7	29	5	2	10

(22.) yds.	qrs.	nls.	in.
361	3	3	2
578	2	2	1
824	3	2	2
968	3	1	2

(23.) sq. m.	ac.	ro.	po.	sq. yds.	sq. ft.	sq. in.
111	327	3	39	29	8	139
222	548	3	38	28	7	143
367	629	2	37	27	6	142
456	385	2	36	26	5	138
888	466	3	38	25	4	129

4.)	wks.	days	hrs.	min.
	83	6	23	59
	62	5	22	58
	71	4	21	52
	45	3	17	57
	28	6	19	49

(25.)	qr.	bush.	pks.	gall.	qts.	pts.
	8	7	3	1	3	1
	9	6	3	1	2	0
	10	5	2	0	3	1
	11	4	2	1	3	1
	12	7	3	0	2	1

COMPOUND COMPLEMENTARY ADDITION.

Compound Complementary Addition is the method of finding the difference between any two compound or mixed quantities. This rule involves no new principle.

The intelligent scholar will perceive that it is in the compound rules *equally* with the simple quantities that the extreme simplicity, utility, and value of Complementary Addition assert themselves. We will suppose that the reader has been making a purchase of some small articles amounting in all to 15*s.* 8¾*d.*, for which he tenders a one pound note. What can surpass the simplicity of the transaction as the tradesman with money in his hand counts down the change. He says 15*s.* and ¾*d.* with ¼ (puts it down) make 15*s.* 9*d.*; and 3*d.* (puts it down) make 16*s.*, and 4*s.* (puts it down) make one pound. Are we not taught a most practical lesson by this, and is it not high time our girls and boys learned the lesson?

RULE XXXVII.

To find the difference between any two compound or mixed quantities.

1°. Place the lesser of the two quantities under the greater; like terms being vertically below each other.

2°. Commencing at the right-hand column add as in Simple Complementary Addition, carrying as directed in the preceding Rule (XXXVI.).

Illustrative Examples. — (1.) Find the difference between £987, 16*s.* 11¾*d.* and £324, 4*s.* 2½*d.*

Explanation:—The work runs thus: 2 farthings and 1 (put it down) make 3; 2 pence and 9 pence (put it down) make 11*d.*; 4 shillings and 12 shillings (put it down) make 16*s.*; 4 and 3 (down) make 7; 2 and 6 (down) make 8; 3 and 6 (down) make 9, and the answer is obtained.

£	*s.*	*d.*
987	16	11¾
324	4	2½
663	12	9¼

(2.) Find the difference between £1864, 11*s.* 4¼*d.* and £989, 15*s.* 9¾*d.*

Explanation:—We work as follows: 3 farthings and 2 farthings (down) make 5 or 1¼*d.*, carry 1*d.*; 9 and 1 are 10, 10 and 6 (down) are 16*d.* = 1*s.* 4*d.*, carry 1*s.*; 15 and 1 are 16, 16 and 15 (down) are 31*s.* or £1, 11*s.*, carry £1; 9 and 1 are 10, 10 and 4 (down) are 14 and proceed as in Rule IV.

£	*s.*	*d.*
1864	11	4¼
989	15	9¾
874	15	6½

Exercise 37.

Find the difference between—

	£	*s.*	*d.*		£	*s.*	*d.*
(1.)	93714	10	6	and	7658	13	9
(2.)	772301	8	4	„	92491	14	5
(3.)	8379654	13	2¼	„	796877	15	9
(4.)	8133	11	6½	„	533	13	8
(5.)	4586	7	9¼	„	1397	18	10½
(6.)	6302	11	2½	„	281	13	5¾
(7.)	1	1	2½	„	0	11	11¾
(8.)	12	0	0	„	3	11	3¾
(9.)	25	16	4	„	21	11	11¾
(10.)	729	12	8½	„	391	15	6¾
(11.)	562	10	3½	„	456	13	5¾

(12.) 6 ac. 3 ro. 30 po. 25 yds. „ 4 ac. 3 ro. 33 po. 28¾ yds.
(13.) 2 tons 18 cwts. 2 qrs. 25 lbs. „ 1 ton 19 cwts. 3 qrs. 27 lbs.
(14.) 5 mls. 3 fur. 0 po. 4 yds. „ 4 mls. 7 fur. 2 po. 4¾ yds.
(15.) 16 lbs. 3 oz. 16 dwts. 20 grs. „ 12 lbs. 10 oz. 18 dwts. 23 grs.
(16.) 25 yds. 3 qrs. 2 nls. 1 in. „ 21 yds. 3 qrs. 3 nls. 2 in.
(17.) 15 wks. 5 dys. 20 hrs. 50 sec. „ 12 wks. 6 days 21 hrs.
(18.) 120 lbs. 5 oz. 4 drs. 2 scr. 4 grs. „ 6 lbs. 8 oz. 7 drs. 2 scr. 18 grs.

COMPOUND MULTIPLICATION.

Compound Multiplication is the method of finding one quantity which shall be equal to a given mixed or compound quantity repeated or added to itself any given number of times.

RULE XXXVIII.

To multiply a compound quantity.

1°. Place the multiplier under the right-hand or lowest denomination of the multiplicand and draw a line below.

2°. Begin the multiplication at the lowest denomination, reducing and carrying as in Compound Addition.

Note 1. — When the multiplier is a composite number greater than 20 break it up into convenient factors and multiply by them in succession. The last product will be the answer.

Note 2. — When the multiplier is very large or a prime number, either of the two methods exhibited may be taken.

Illustrative Examples.—Multiply £151, 13*s.* 7¼*d.* by 7, also by 132, and by 701.

$$\begin{array}{rrr} \pounds & s. & d. \\ 151 & 13 & 7\frac{1}{4} \\ & & 7 \\ \hline 1061 & 15 & 2\frac{3}{4} \\ \hline\hline \end{array}$$

$$\begin{array}{rrr} \pounds & s. & d. \\ 151 & 13 & 7\frac{1}{4} \\ & & 11 \\ \hline 1668 & 9 & 7\frac{3}{4} \\ & & 12 \\ \hline 20021 & 15 & 9 \\ \hline\hline \end{array}$$

$$\begin{array}{rrr} \pounds & s. & d. \\ 151 & 13 & 7\frac{1}{4} \\ & & 7 \\ \hline 1061 & 15 & 2\frac{3}{4} \\ & & 10 \\ \hline 10617 & 12 & 3\frac{1}{2} \\ & & 10 \\ \hline 106176 & 2 & 11 \\ 151 & 13 & 7\frac{1}{4} \\ \hline 106327 & 16 & 6\frac{1}{4} \\ \hline\hline \end{array}$$

These processes require no explanation.

or

$$\begin{array}{rrr} \pounds & s. & d. \\ 151 & 13 & 7\frac{1}{4} \\ & & 701 \\ \hline 106327 & 16 & 6\frac{1}{4} \\ \hline\hline \end{array}$$

Exercise 38.

	£	s.	d.	
(1.)	5682	15	6¼	× 9.
(2.)	3975	15	3¼	× 9.
(3.)	65943	17	11¾	× 11.
(4.)	1375	0	8¾	× 8.
(5.)	4964	14	7¾	× 7.
(6.)	3	7	11½	× 35.
(7.)	45	19	9½	× 8.
(8.)	45	19	9½	× 80.
(9.)	91	19	7	× 44.
(10.)	5	10	4¾	× 120.
(11.)	4645	11	2½	× 75.
(12.)	5943	10	5¾	× 73.
(13.)	7365	9	4¼	× 97.

	£	s.	d.	
(14.)	1375	0	8¾	× 17.
(15.)	399	11	4½	× 59.
(16.)	388	12	9¾	× 47.
(17.)	3	19	9¾	× 245.
(18.)	9	0	11¾	× 23.
(19.)	1	9	6	× 339.
(20.)	29	19	10¾	× 192.
(21.)	149	17	10	× 23.
(22.)	7850	11	8¾	× 47.
(23.)	8631	17	9¼	× 59.
(24.)	5	3	9	× 7339.
(25.)	0	19	11¾	× 311.

(26.)	11 cwts. 3 qrs. 15 lbs. 4 oz.	× 46.
(27.)	1 mile 7 fur. 39 poles	× 41.
(28.)	1 cwt. 27 lbs. 15 oz.	× 17.
(29.)	18 tons 3 cwts. 2 qrs. 9 oz.	× 23.
(30.)	2 tons 9 cwts. 15 lbs. 9 oz.	× 27.
(31.)	1 yard 2 in.	× 37.
(32.)	2 dwts. 2 grs.	× 101.

RULE XXXIX.

To find what any given sum per day will amount to in a year (365 days).

1°. Take the given price per day (reduced to pence) as so many pence, so many fourpences, so many sovereigns, and so many half-sovereigns.

2°. Add the 4 amounts together for the required quantity.

Illustrative Examples.—1. What will 1*s.* 4*d.* per day amount to in a year?

	£	s.	d.			
	0	1	4	= pay for	1	day.
(1*s.* 4*s.* = 16*d.*)	0	5	4	= „	4	days.
	16	0	0	= „	240	„
	8	0	0	= „	120	„
	24	6	8	= „	365	„

2. What will £2, 2*s.* 3¾*d.* per day amount to in a year?

The £2 per day should be calculated separately as in the example. (2*s.* 3¾*d.* = 27¾*d.*)

£	s.	d.
0	2	3¾
0	9	3
27	15	0
13	17	6
730	0	0
772	4	0¾

The following table should be remembered:—

One farthing	per day is	£0, 7*s.* 7¼*d.*	per year.
One penny	„	£1, 10*s.* 5*d.*	„
Sixpence	„	£9, 2*s.* 6*d.*	„
One shilling	„	£18, 5*s.* 0*d.*	„

Exercise 39.

Find what the following sums per day will amount to in a year:—

(1.) 0*s.* 3½*d.* per day.
(2.) 0*s.* 11¼*d.* „
(3.) 0*s.* 10¾*d.* „
(4.) 1*s.* 2*d.* „
(5.) 1*s.* 3¾*d.* „
(6.) 1*s.* 5½*d.* „
(7.) 1*s.* 7¾*d.* „
(8.) 1*s.* 8½*d.* „
(9.) 1*s.* 9¼*d.* „
(10.) 1*s.* 10¾*d.* „
(11.) 2*s.* 0¼*d.* „
(12.) 2*s.* 1½*d.* „
(13.) 2*s.* 3¾*d.* „
(14.) 1*s.* 11¾*d.* „
(15.) 2*s.* 5*d.* „
(16.) 2*s.* 7*d.* per day.
(17.) 2*s.* 8*d.* „
(18.) 2*s.* 6*d.* „
(19.) 2*s.* 10¼*d.* „
(20.) 2*s.* 11*d.* „
(21.) 3*s.* 0¾*d.* „
(22.) 3*s.* 1½*d.* „
(23.) 3*s.* 6*d.* „
(24.) 3*s.* 9*d.* „
(25.) 4*s.* 2*d.* „
(26.) 4*s.* 8*d.* „
(27.) 5*s.* 6*d.* „
(28.) 6*s.* 3*d.* „
(29.) 7*s.* 2*d.* „
(30.) 8*s.* 4*d.* „

COMPOUND DIVISION.

Compound Division is the method of finding (1) any quired part of a given mixed or compound quantity; (2) h often one compound quantity is contained in another co pound quantity of a similar kind.

RULE XL.

To divide a compound quantity by a simple integral nu ber.

1°. Place the divisor and dividend as in Simple Long Di sion, and divide the highest denomination by the divis placing the quotient under the divisor.

2°. Reduce the excess or overplus to the next lower de mination and again divide.

3°. Reduce again as in 2° and divide as in 1°, adding at e reduction any number of the lower denomination there n be in the original dividend.

4°. Each quotient number will be of that denomination which the division takes place.

Illustrative Example.—Divide £12345, 6*s.* 7½*d.* by 7 a by 79.

	£	*s.*	*d.*
7)	12345	6	7½
	1763	12	4½

	£	*s.*	*d.*
79	12345	6	7½
£156 5 4¾	444		
	495		
	21	(× 20)	
	426		
	31	(× 12)	
	379		
	63	(× 4)	
	254		
	17	Excess.	

The multipliers used in the reduction are not inserted. The working is more consistent and beautiful without them. They may, however, be written if desired, or placed by the side, as in the example.

Exercise 40.

(1.) £149, 6*s*. 10½*d*. ÷ 6.
(2.) £2,065, 19*s*. 6*d*. ÷ 8.
(3.) £153, 1*s*. 3¾*d*. ÷ 9.
(4.) £6, 9*s*. 5¾*d*. ÷ 11.
(5.) £145,845, 17*s*. 9¾*d*. ÷ 15.
(6.) £76,873, 15*s*. 7½*d*. ÷ 16.
(7.) £48, 6*s*. 3*d*. ÷ 24.
(8.) £135, 13*s*. 4½*d*. ÷ 42.
(9.) £6,595, 4*s*. 8*d*. ÷ 44.
(10.) £3,050, 9*s*. 10½*d*. ÷ 81.
(11.) £21,240, 4*s*. 0*d*. ÷ 96.
(12.) £15,942, 16*s*. 6*d*. ÷ 108.
(13.) £102,354, 14*s*. 8¼*d*. ÷ 93.
(14.) £1,468, 16*s*. 3*d*. ÷ 426.
(15.) £35,746, 13*s*. 6½*d*. ÷ 316.
(16.) £2,825,595, 9*s*. 3½*d*. ÷ 34.
(17.) £405,211, 0*s*. 3½*d*. ÷ 38.
(18.) £2,065, 19*s*. 6*d*. ÷ 23.
(19.) £317,235, 1*s*. 6¾*d*. ÷ 145.
(20.) £153, 1*s*. 3¾*d*. ÷ 29.
(21.) £146, 14*s*. 10½*d*. ÷ 53.
(22.) £21,544, 14*s*. 2½*d*. ÷ 97.
(23.) £39, 11*s*. 3¼*d*. ÷ 19.
(24.) £99, 2*s*. 9¾*d*. ÷ 47.
(25.) £1,549, 19*s*. 4¾*d*. ÷ 31.
(26.) £379, 19*s*. 7¼*d*. ÷ 19.
(27.) £208, 2*s*. 6¼*d*. ÷ 23.
(28.) £22,912, 9*s*. 0½*d*. ÷ 53.
(29.) £1,220,314, 3*s*. 1¾*d*. ÷ 73.
(30.) £2,586, 15*s*. 4¼*d*. ÷ 97.

(31.) 8 mls. 3 fur. 25 poles 3 yds. 1 ft. 6 in. ÷ 6.
(32.) 7 tons 6 cwts. 3 qrs. 17 lbs. 2 oz. ÷ 9.
(33.) 2 tons 15 cwts. 1 qr. 2 lbs. ÷ 20.
(34.) 18 mls. 3 fur. 23 poles 1½ yds. 1 ft. ÷ 35.
(35.) 10 tons 8 cwts. 3 qrs. 11 lbs. 12 oz. 15 drs. ÷ 69.
(36.) 30 tons 6 cwts. 1 qr. 24 lbs. 8 oz. ÷ 168.
(37.) 53 qrs. 6 bushels 2 pecks 3 quarts 1 pint ÷ 217.
(38.) 69 mls. 7 fur. 39 poles 2 ft. ÷ 492.
(39.) £34,161, 17*s*. 11*d*. ÷ 2705.
(40.) 198 acres 3 roods 16 poles 3 yds. 72 ins. ÷ 187.

RULE XLI.

To divide one compound quantity by another, *i.e.* to find how often one compound quantity is contained in another compound quantity of a similar kind.

1°. Reduce both quantities to the lowest denomination mentioned in either of the given quantities.

2°. Divide the greater result by the less.

Illustrative Examples.—1. How often is £10, 17*s*. 6*d*. contained in £5383, 2*s*. 6*d*.?

```
£10 17  6             £5383  2  6
  8                       8
----------           ------------
 87               87 | 43065
             --------|------
            Ans. 495 |  826
                 === |  ----
                     |   435
                     |   ---
                     |   ...
```

As each quantity contains an even number of half-crow we reduce both amounts to half-crowns and not to pence.

2. How often is 4 cwts. 3 qrs. 14 lbs. contained in 4704 cw 1 qr. 14 lbs.?

```
4 cwts. 3 qrs. 14 lbs.   4704 cwts. 1 qr. 14 lbs.
146                        56490
---                     ------------------
546                546 | 526890
              ---------|-------
              Ans. 965 |  3549
                   === |  ----
                       |   2730
                       |   ----
                       |   ....
```

The illustrative examples throughout the compound rul have been taken principally in money for obvious reasons, o of which is that the money table is generally best know another is that it is the most important.

Exercise 41.

(1.) How often is 195 yds. 1 ft. 8 in. contained in 1 mile?

(2.) How often does £43, 6*s.* 8*d.* contain £3, 6*s.* 8*d.*?

(3.) How many times is three hundredweight three quarte and fifteen pounds contained in twenty-seven hundre weight twenty-one pounds?

(4.) How many persons can be paid 11*s.* 3*d.* each out o £170, 10*s.* 2*d.*, and what will be the odd money over?

(5.) *a.* £1457, 12*s.* 10½*d.* ÷ £85, 14*s.* 10½*d.*
b. £3141, 5*s.* 2¾*d.* ÷ £84, 17*s.* 11¾*d.*
c. £2330, 5*s.* 10¾*d.* ÷ £56, 16*s.* 8¾*d.*
d. £25216, 0*s.* 8*d.* ÷ £71, 12*s.* 8¾*d.*
e. £69699, 3*s.* 0*d.* ÷ £53, 15*s.* 7¼*d.*
f. £9952, 3*s.* 0*d.* ÷ £47, 16*s.* 11¼*d.*
g. £24738, 13*s.* 1½*d.* ÷ £48, 17*s.* 9¾*d.*

h. £37933, 8*s.* 5*d.* ÷ £37, 15*s.* 7¾*d.*
k. £93938, 2*s.* 8*d.* ÷ £91, 14*s.* 8¾*d.*
l. £728200, 13*s.* 9*d.* ÷ £73, 14*s.* 8¼*d.*
m. 1281 tons 11 cwts. 16 lbs. ÷ 37 tons 13 cwts. 3 qrs. 12 lbs.
n. 1992 lbs. 9 oz. 10 grs. ÷ 56 lbs. 11 oz. 4 dwts. 14 grs.
o. 40895 lbs. 11 oz. 1 scr. ÷ 85 lbs. 10 oz. 7 dr. 2 scr. 15 grs.
p. 51437 miles 1 fur. 35 poles 4½ yds. 2 ft. 4 in. ÷ 91 miles 6 fur. 32 poles 3 yds. 2 ft. 8 in.
q. 79157 ac. 3 ro. 24 poles 4 yds. 3 ft. 38 in. ÷ 81 ac. 2 ro. 16 poles 29 yds. 3 ft. 143 in.
r. 74944 yds. 2 qrs. 0¾ in. ÷ 92 yds. 3 qrs. 1 nl. 2 in.
s. 58382 hhds. 12 gals. 3 qts. 1 pt. 2 gills ÷ 75 hhds. 57 gals. 3 qts. 1 pt. 2 gills.
t. 1086 qrs. 1 bus. 1 gal. ÷ 37 qrs. 3 bus. 2 pks. 1 gal.
u. 35243 qrs. 2 bus. 1 pk. ÷ 59 qrs. 5 bus. 3 pks. 1 gal.
v. 1479 days 17 hrs. 40 sec. ÷ 39 days 23 hrs. 48 min. 40 sec.
w. 5281 days 9 hrs. 45 min. 50 sec. ÷ 78 days 19 hrs. 50 min. 50 sec.
x. 7993 days 11 hrs. 3 min. 39 sec. ÷ 85 days 22 hrs. 49 min. 43 sec.
y. 25004 yrs. 323 days 4 hrs. 9 min. ÷ 27 yrs. 54 days 15 hrs. 29 min.
z. 29213 yrs. 33 days 4 hrs. 4 min. ÷ 27 yrs. 54 days 15 hrs. 29 min.

MISCELLANEOUS QUESTIONS

ON THE PRECEDING RULES.

The first section of the following examples refers to the general rules; the second section has special reference to the particular and contracted methods. It is hoped that a sufficient number has been provided to thoroughly test the student's proficiency up to this point in his studies. At this stage it may be best to state that of necessity the words *subtraction*, *remainder*, &c., will occur in Miscellaneous and Examination Questions, but all such questions are, of course, to be solved on the Incremental or Complementary principle as taught throughout this Manual.

I.

(1.) Obtain the sum of forty-six times seven thousand a twenty, seventeen times one million and one, and thirt three times thirty-three.

(2.) Write down in figures twelve hundred million sixte hundred and one.

(3.) Express in words 11603700160 and write the numbe 4967 and 10684 in Roman numerals.

(4.) In 674381 inches how many miles?

(5.) Add together 50718, 50, 7189, 907, 6009.

(6.) The population of England in 1841 was 14995132 and 1851 was 16854142. Find the total increase and t average increase per year.

(7.) What sums will be left when the amounts £5, 10*s.* 7½ £12, 18*s.* 6¾*d.*, £9, 4*s.* 6¼*d.*, and £3, 2*s.* 4½*d.* of four bi have been paid out of £35?

(8.) How many tons of coal will be required to supply 12 fi for 27 weeks, each fire consuming 1 cwt. 1 qr. 14 lbs. coal weekly?

(9.) What will be left out of £50 after paying £9, 17*s.* 4 £4, 12*s.* 6½*d.*, £5, 10*s.* 9¾*d.*, £27, 5*s.* 2¼*d.*?

(10.) Multiply 658302 by 6309 and divide the product by 70

(11.) A gentleman's income in 1861 was £685, out of which saved £274, 7*s.* 6*d.* What was his average daily e penditure?

(12.) The populations of 9 towns and villages are 16640, 3 3750, 3906, 5144, 2684, 13360, 391, and 5797 respectivel by how much does the aggregate fall short of a millio

(13.) Add together 56841, 7345, 860, 7843217, 14, and 50010

(14.) Show that there are as many farthings in £59, 12*s.* 1¾ as pounds in 25 tons 10 cwts. 3 qrs. 19 lbs.

(15.) Find the cost of 357 tons of coal at £1, 3*s.* 9*d.* per ton.

(16.) The following sums are given to a charity—£17, 3*s.* 2 £12, 19*s.* 5½*d.*, £21, 17*s.* 11*d.*, and £24, 12*s.* 10*d.*, an the whole amount is then divided amongst 47 poor pe sons equally. What will each receive?

(17.) A ship brings home 935583 lbs. of tea. What is th amount in tons, cwts., qrs., and lbs.?

(18.) Find by how much the product of 567 and 809 is great than their sum.

(19.) Add together £7, 19*s.* 6¾*d.*, £11, 0*s.* 10*d.*, £28, 3*s.* 4½*d.*, £16, 8*s.* 0¼*d.*, and find the difference between the sum and £100.

(20.) How many lots of 1 ton 12 cwts. 2 qrs. 25 lbs. can be obtained from 57 tons 5 cwts. 1 qr. 7 lbs.?

(21.) Explain meaning of terms "*unit*," "*number*," "*abstract number*," "*concrete number*."

(22.) Reduce 527895 inches to poles, &c.

(23.) How many times is £17, 5*s.* 9½*d.* contained in £100, and what is the remainder?

(24.) Divide 15997 by 21 by short divisions, giving reasons for last or true remainder.

(25.) How many tons, &c., are there in as many ounces as there are seconds in a week?

(26.) How many minutes are there in the 5 following years, of which the first is 1862?

(27.) A bar of metal weighing 100 oz. 16 dwts. is made into coins weighing 1 oz. 8 dwts. each. How many coins were struck?

(28.) Divide 7654321 by 126, (1) by long division, (2) by short division by factors, and show that the results agree.

(29.) A bar of gold weighing 196 lbs. 10 oz. 10 dwts. is cased in lead weighing 24 lbs. 14 oz. Find the whole weight Avoirdupois.

(30.) Reduce £36, 3*s.* 4½*d.* to halfpence.

(31.) The weights of Bow Bells are respectively 2 tons 13 cwts. 25 lbs., 1 ton 14 cwts. 2 qrs. 16 lbs., 1 ton 6 cwts. 3 lbs., 1 ton 1 cwt. 23 lbs., 16 cwts. 4 lbs., 13 cwts. 2 qrs. 22 lbs., 12 cwts. 7 lbs., 10 cwts., 9 cwts. 1 qr. 5 lbs., and 8 cwts. 3 qrs. 7 lbs. Find the total weight and also their average weight.

(32.) Find the product of the sum and difference of two hundred and thirty-eight thousand four hundred and twenty-eight, and one hundred and five thousand and sixty-nine.

(33.) If the French pay off their debt at the rate of five hundred million four hundred and sixty-three thousand two hundred and fifty francs for a year, how much will they have paid in thirteen years? If this is at the rate of fourteen francs a year for each person what is the population?

(34.) A railway is 1572 miles long. Find the number of bolts required to fix the chairs for the rails upon the sleepers, there being two bolts to each chair, 2 chairs to each sleeper, and 2 sleepers upon an average to every 22 inches of the whole line of railway.

(35.) Multiply £13, 15*s.* 2¾*d.* by 35, and divide £816, 15*s.* 7½*d.* by 59.

(36.) In building a viaduct of one hundred and one arches, ninety thousand and nine bricks are used for each arch. How many bricks are used altogether?

(37.) What does a collector receive in 4 years, his weekly receipts being £7, 4*s.* 3*d.*? Find his yearly income at 1*s.* 8*d.* in the pound.

(38.) How much mutton at 7½*d.* per pound can be bought for £27, 18*s.* 9*d.*?

(39.) How much will it cost top-seeding 3 acres of potatoes at 6½*d.* per stone when 2 stones are required for 3 perches?

(40.) In 42 mls. 4 fur. 3 poles 4 yds. how many feet?

(41.) Reduce 4 acres 20 poles to feet.

(42.) Reduce 9 miles 3 fur. 6 poles 1 yd. to feet.

(43.) Reduce 9503707 pints to quarters, bushels, &c.

(44.) A grocer buys 200 lbs. of sugar at 5¼*d.* per pound. What is the total cost?

(45.) Divide £1520 among A, B, and C, so that B may have £100 more than A, and C £270 more than B.

(46.) If the moon moves forward in her orbit 57° 1′ 18″ in 13 days, calculate her daily motion.

(47.) Divide £55, 6*s.* 10½*d.* equally among 35 persons and find how much 3 will receive.

(48.) A person expends £1000 in the purchase of shares at £12, 17*s.* 6*d.* each. If the expenses of purchase are £8, 12*s.* 6*d.* how many shares are bought?

(49.) A man earns 11¾*d.* daily. How much will he earn in 313 days?

(50.) I bought 59 horses for £1040, 19*s.* 7½*d.* What was the cost of each?

(51.) Divide £300, 18*s.* 10½*d.* between A and B, giving B £50, 12*s.* 6*d.* more than A.

(52.) Find the difference between 169 lbs. 6 oz. 14 dwts. 17 grs. and 187 lbs. 9 oz. 12 dwts. 20 grs.

(53.) Reduce 174082 inches to miles, furlongs, &c.

(54.) In 1721793 inches how many miles, furlongs, &c.?

) How many pounds of silver are there in 270 spoons, each of which weighs 1 oz. 13 dwts. 8 grs.?

) How many acres, &c., in 120505 sq. ft.?

) Express 4040789 grains in lbs., ozs., dwts., &c.

) If 451 tons of copper ore are exchanged for 8003 tons 17 cwts. 1 qr. 7 lbs. 6 oz. of iron ore, how much of the latter is given for each ton of copper ore?

.) A pendulum vibrates 47 times each minute. How many vibrations will it make in 196 days 49 minutes?

.) Add together 480 acres, the fourth of 3 acres, and 98 sq. yds., giving the answer in square feet.

.) An equal number of men, women, and boys earn £24, 15*s.* in 6 days, the daily wages of a man being 1*s.* 4*d.*, a woman 10*d.*, and a boy 4*d.* How many were there of each?

2.) Divide the difference between a guinea and a crown by 128.

3.) In 50 acres how many square inches?

4.) In 3 leagues how many inches?

5.) Divide 467 tuns 3 hhds. 26 galls. 2 qts. 1 pt. by 5.

II.

) Multiply 9871236 by 1682, 81273, 64164, 252366, and by 729819 each in three lines of figures of multiplication only.

) Multiply 1234987 by 999, 989, 9995, 99991, and by 99999988 in only one line of multiplication.

)
a. 1567893
b. 1681406
c. 9721981
d. 5612301
e. 4089576
f. 2384764
g. 8196321
h. 4576528
k. 5674329
l. 8921576
m. 3621487
n. 2157576

Multiply by 11, 11115, and 1111114, each in one line only.

(4.) Multiply 15347618 by 21, 22, 23, 24, 26, 27, 28, 29, in line.

(5.)

$$\left.\begin{array}{r} a.\ 415678 \\ b.\ 216814 \\ c.\ 397219 \\ d.\ 561230 \\ e.\ 408957 \\ f.\ 238475 \\ g.\ 819632 \\ h.\ 457652 \\ k.\ 567432 \\ l.\ 892157 \\ m.\ 362148 \\ n.\ 215757 \end{array}\right\} \begin{array}{c} \text{Divide by} \\ 5, \\ 25, \\ 125, \\ 45, \\ 55, \\ 35, \\ 75, \\ 175, \\ 225, \\ 275, \end{array} \text{ by short methods.}$$

(6.)

$$\left.\begin{array}{r} a.\ 588867 \\ b.\ 322245 \\ c.\ 711182 \\ d.\ 433354 \\ e.\ 788891 \\ f.\ 166676 \\ g.\ 981117 \\ h.\ 432221 \\ k.\ 454545 \\ l.\ 776655 \end{array}\right\} \times \left\{\begin{array}{l} 5,\ 25,\ 35,\ 45,\ 55,\ 75, \\ 125,\ 375,\ 875,\ 154,\ 165, \\ 176,\ 175,\ 275. \\ \quad \text{All by short methods.} \end{array}\right.$$

(7.)

$$\left.\begin{array}{r} a.\ 15784632987 \\ b.\ 91563214572 \\ c.\ 86416821483 \\ d.\ 29645729856 \\ e.\ 81432964743 \end{array}\right\} \div \left\{\begin{array}{l} 999 \\ 9999 \\ 99999 \\ 999999 \end{array}\right.$$

HIGHEST COMMON FACTOR

OR

GREATEST COMMON MEASURE.

The H.C.F. or G.C.M. of two or more quantities is the argest number that is contained exactly in each of the given uantities, and the rule of H.C.F. or G.C.M. is the method f finding that number.

Rule XLII.

To find the H.C.F. of two numbers.

1°. Place the numbers side by side with a vertical line between them.

2°. Divide the greater by the less and write down the increment or excess.

3°. Repeat the operation of dividing the greater by the less, making the excess the new divisor at each division until there is no excess.

4°. The last divisor will be the required H.C.F. or G.C.M.

Note 1.—Any factor or measure in either quantity, or in any one of the increments, that is evidently *not* common may be taken out and rejected, whilst any factor obviously common may be taken out and retained.

Note 2.—The proof of the rule, or the principle involved in it, is that if any number measures two other numbers, it must necessarily measure the difference of those numbers. To put the theory simply; if, say, 8 is a measure of two numbers, we mean that each number is made up exactly of so many 8's. Consequently, if we take the number of 8's in the smaller number and compare it with the number of 8's in the larger quantity, the increment or complement must also be a certain number of 8's. Therefore the difference or complement must be divisible by 8. The algebraical proof, of course, is the general proof, and can be seen in any work on the subject.

Illustrative Examples.—Find the H.C.F. of 51975 and 67

1st Method:—

51975	67276
6072	15301
2915	3157
11	242
	...

Explanation:—

Dividing 67276 by 51975 the overplus is 15301
„ 51975 „ 15301 „ „ 6072
„ 15301 „ 6072 „ „ 3157
„ 6072 „ 3157 „ „ 2915
„ 3157 „ 2915 „ „ 242
„ 2915 „ 242 „ „ 11
„ 242 „ 11 „ „ 0

∴ 11 = H.C.F.

2nd Method:—

51975	67276
4725	6116
189	1529

11 retained and Ans.

Explanation: 11 is obviously a *common* factor, it is there taken out and retained, leaving the quotients 4725 and 61 25 is evidently a factor of the first, as 4 is of the second, t are taken out and rejected, leaving as quotients 189 and 1 The first of these quotients is made up of the factors 3 an neither of which is a factor of 1529. The two quotients b prime to each other, the H.C.F. is the retained measure 11 this question the only common factor). Should there be n than one common factor the H.C.F. is the continued proc of all such common factors.

The above question worked in the ordinary way as gi in the best text-books employs about 88 figures, whereas than 20 are sufficient for the purpose, and the processes much simpler and easier.

If it be required to find the H.C.F. of more than two n bers, say of four, find the H.C.F. of any two, then of the o two; next find the H.C.F. of the results already found, *the last result* will be the required answer.

Find the H.C.F. of 1386, 792, 2592, 8316.

1386	792	2592	8316	108	198
594	198	432	540	18	90
...		...	108		..

∴ 18 is the H.C.F. required.

Exercise 42.

Find the H.C.F. of the following quantities:—

(1.) 501 and 1837
(2.) 169037 „ 66429
(3.) 5568981 „ 506382
(4.) 15463 „ 554470
(5.) 23760 „ 26136
(6.) 6023 „ 15466
(7.) 40457 „ 420325
(8.) 4046 „ 15162
(9.) 1404 „ 1264
(10.) 1242 „ 1314
(11.) 6888 „ 1134
(12.) 11088 „ 13104
(13.) 8134 „ 2573
(14.) 10395 „ 84095
(15.) 72831 „ 910404
(16.) 321652 and 315672
(17.) 6655 „ 7766
(18.) 12345 „ 98763
(19.) 33495 „ 106260
(20.) 48569 „ 24293
(21.) 63529 „ 61013
(22.) 75582 „ 42237
(23.) 359784 „ 95469
(24.) 1973594 „ 180194
(25.) 333567 „ 436203
(26.) 232001 „ 70609
(27.) 7010117 „ 256417
(28.) 113960 „ 99715
(29.) 2592525 „ 1832051
(30.) 1006110363 „ 496606401

(31.) 5049, 4301, 3553.
(32.) 8214, 1110, 1702.
(33.) 47495, 138355, 684740.
(34.) 27720, 396, 5184.
(35.) 8316, 2772, 4257.

LOWEST COMMON MULTIPLE.

The Lowest (or Least) Common Multiple of two or more numbers is the lowest (or least) number that will contain all the given numbers exactly without excess.

RULE XLIII.

To find the L.C.M. of two numbers.

1°. Find the H.C.F. of the two numbers.

2°. Divide either of the numbers by this H.C.F. and multiply the other number by the quotient.

Illustrative Example.—Find the L.C.M of 1584 and 1188.

1188 divided by 396 (the H.C.F.) gives 3.

∴ 3 times 1584, or 4752, is the answer required.

$$\begin{array}{r|r} \underline{1188} & \underline{1584} \\ .. & 396 \end{array}$$

Exercise 43.

Find the L.C.M. of the following numbers:—

(1.) 2662 and 2904.
(2.) 2673 „ 2916.
(3.) 2695 „ 8085.
(4.) 3125 „ 5625.
(5.) 3993 „ 9317.
(6.) 9604 „ 3773.
(7.) 9375 „ 6875.
(8.) 9317 „ 7623.
(9.) 9072 „ 5544.
(10.) 8712 „ 5346.
(11.) 3456 „ 7776.
(12.) 9261 and 3528.
(13.) 3168 „ 8712.
(14.) 3136 „ 8624.
(15.) 3675 „ 8505.
(16.) 3465 „ 9072.
(17.) 8064 „ 2772.
(18.) 9801 „ 3388.
(19.) 9856 „ 2816.
(20.) 2352 „ 7392.
(21.) 11704, 101080, 138945.
(22.) 27720, 396, 5184.

RULE XLIV.

To find the L.C.M. of three or more numbers.

1°. Throw out any one (or more) of the given numbers which is contained exactly in another of those numbers.

2°. Take for *simultaneous* divisors as many of the numbers 2, 3, 5, 7, 11, 13, 17, 19 as are seen by inspection to be contained exactly in two or more of the given numbers.

3°. Employ every divisor possible, but only once, upon each *number in the* series.

4°. If necessary bring down the divisors again and repeat the division, observing direction 1° after each division.

5°. The product of all the divisors actually used, and the quotients greater than unity, is the desired L.C.M.

Note.—When no divisor will exactly measure a number in the series, that number is to be brought down unchanged. After considerable practice the substitution of 4 or 8 for 2 and 9 for 3 will often be preferable, but the pupil must be careful to throw out any factor *common* to the divisor and the number under consideration, although the divisor itself will not measure that number. The use of these composite divisors is illustrated in the second method of solution.

Illustrative Example.—What is the L.C.M. of 27 . 91 . 42 . 36 . 63 . 156 . 234.

$$\begin{array}{rl} 2 . 3 . 7 . 13\ ) & \underline{27 . 91 . 42 . 36 . 63 . 156 . 234} \\ 3\ ) & \underline{9 . \qquad\qquad 6 . \cancel{3} . \cancel{2} . \cancel{3}} \\ & 3 . \qquad\qquad 2 . \end{array}$$

$$\therefore \text{L.C.M.} = 2 \times 3 \times 7 \times 13 \times 3 \times 3 \times 2 = 9828. \quad \text{Ans.}$$

2nd Method, by composite divisors:—

$$\begin{array}{rl} 4 . 7 . 9 . 13\ ) & \underline{27 . 91 . 42 . 36 . 63 . 156 . 234} \\ & 3 . \end{array}$$

$$\therefore \text{L.C.M.} = 4 \times 7 \times 9 \times 13 \times 3 = 9828. \quad \text{Ans.}$$

$$\left.\begin{array}{llll} \text{Here } 91 & \text{is made up of factors} & & 7 \text{ and } 13 \\ \quad 42 & \quad ,, & ,, & 2, 3, \text{ and } 7. \\ \quad 36 & \quad ,, & ,, & 4 \text{ and } 9. \\ \quad 63 & \quad ,, & ,, & 7 \text{ and } 9. \\ \quad 156 & \quad ,, & ,, & 3, 4, \text{and } 13. \\ \quad 234 & \quad ,, & ,, & 2, 9, \text{and } 13. \end{array}\right\} \begin{array}{l} \text{All of which} \\ \text{factors are found} \\ \text{in the divisors} \\ 4, 7, 9, \text{ and } 13. \end{array}$$

The quotients in all these cases are consequently unity, which need not be written down.

Exercise 44.

Find the L.C.M. of the following quantities:—

(1.) 44 . 48 . 52 . 96.
(2.) 32 . 48 . 14 . 40.
(3.) 11 . 30 . 42 . 66 . 90.

Find the L.C.M. of the following quantities:—

(4.) 26 . 33 . 39 . 44.
(5.) 125 . 136 . 180 . 24 . 27.
(6.) 48 . 27 . 81 . 165 . 110.
(7.) 18 . 16 . 36 . 44 . 45 . 48 . 63 . 121.
(8.) 9 . 11 . 18 . 22 . 36.
(9.) 60 . 90 . 25 . 105 . 9.
(10.) 76 . 152 . 38 . 448 . 748.
(11.) 12 . 16 . 18 . 30 . 48.
(12.) 12 . 11 . 10 . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2.
(13.) 5 . 7 . 9 . 11 . 13 . 15 . 17 . 19 . 21 . 23.
(14.) 27 . 25 . 23 . 21 . 19 . 17 . 15 . 13.
(15.) 14 . 16 . 18 . 20 . 22 . 24 . 26 . 28.
(16.) 24 . 32 . 36 . 32 . 40 . 42.
(17.) 36 . 42 . 48 . 54 . 60.
(18.) 30 . 18 . 24 . 40 . 54 . 66.
(19.) 25 . 32 . 63 . 42 . 49 . 84.
(20.) 63 . 70 . 104 . 77 . 132 . 117 . 143.
(21.) 50 . 28 . 35 . 24 . 105 . 72 . 112.
(22.) 238 . 242 . 374 . 308 . 330 . 385 . 462 . 170.
(23.) 48 . 70 . 52 . 30 . 108 . 252 . 312 . 105.
(24.) 252 . 189 . 145 . 210 . 406 . 29 . 77.
(25.) 36 . 42 . 44 . 90 . 198 . 308 . 336.
(26.) 81 . 91 . 84 . 117 . 126 . 312 . 468.
(27.) 36 . 45 . 54 . 63 . 72 . 81 . 90 . 99 . 108.
(28.) 64 . 72 . 80 . 88 . 96 . 104 . 112 . 120.
(29.) 80 . 82 . 84 . 86 . 88 . 90 . 92 . 94 . 96 . 98 . 100.
(30.) 7 . 11 . 21 . 63 . 91 . 99 . 117 . 143 . 159 . 212 . 511 . 583.

FRACTIONAL ARITHMETIC.

VULGAR FRACTIONS.

In approaching the subject of Fractions the student should banish from his mind all ideas of difficulty or perplexity. If rightly undertaken by the pupil and explained by the master fractions can offer no insurmountable obstacles to progress. Nor will junior scholars meet with insuperable and insolvable obstructions.

Unity and units are of course divisible into parts, equal and unequal. These parts are termed "fractions" and are *always* considered as equal, *e.g.* if unity be divided into eleven parts they are considered as *equal* parts, and each part is necessarily an eleventh of the whole. Again, when we speak of nine-tenths of a fortune we first suppose the whole fortune broken up or divided into ten equal portions, each of which is a tenth of the whole, and then nine of these portions are taken. With what are called Vulgar Fractions the "denomination," or number of parts into which unity (or the object) is divided, is called the *Denominator*, and the number of such parts taken to form the fraction is called the *Numerator*. These two are designated the "terms" of the fraction, and they are always written vertically in relation to each other, the Numerator above the Denominator with a horizontal line between them. The word fraction naturally conveys the idea of a part of a thing, and the part is less than the whole, therefore a proper fraction is always less than unity. The pupil is referred to the Glossary for definitions peculiar to this department of Arithmetic.

Extended reasons for the various operations and rules will not be furnished. Certain explanations are, however, introduced wherever essential.

RULE XLV.

To multiply a Vulgar Fraction by an integer.
1°. Multiply the numerator by the integer.

Illustrative Example.—Multiply $\frac{7}{8}$ by 3.

$$\tfrac{7}{8}\times 3=\frac{7\times 3}{8}=\frac{21}{8}\text{ Ans.}$$

It is obvious that seven articles of any kind taken three tim will give twenty-one articles. Should these articles be par of unity (say eighths) the *operation* is unaltered, for thr times seven-eighths will and must result in twenty-o "eighths." Hence the rule as given above.

Exercise 45.

Perform the separate multiplications as indicated:—

(1.) $\frac{15}{16}\times 3, 4, 5, 6.$
(2.) $\frac{14}{17}\times 2, 4, 6, 8.$
(3.) $\frac{7}{11}\times 6, 8, 10, 12.$
(4.) $\frac{16}{19}\times 13, 15, 16, 20.$
(5.) $\frac{8}{9}\times 12, 14, 16, 18.$
(6.) $\frac{91}{100}\times 25, 75, 125, 99.$
(7.) $\frac{81}{82}\times 11, 112, 101, 39.$
(8.) $\frac{72}{73}\times 25, 112, 125, 39.$
(9.) $\frac{64}{65}\times 11, 75, 101, 99.$
(10.) $\frac{56}{57}\times 113, 97, 107, 995.$

RULE XLVI.

To divide a Vulgar Fraction by an integer.
1°. Multiply the denominator by the integer.

Illustrative Example.—Divide $\frac{7}{8}$ by 2.

$$\tfrac{7}{8}\div 2=\frac{7}{8\times 2}=\tfrac{7}{16}.\text{ Ans.}$$

Exercise 46.

Perform the separate divisions as indicated:—

(1.) $\frac{3}{8}\div 2, 3, 4.$
(2.) $\frac{7}{9}\div 3, 4, 5.$
(3.) $\frac{2}{11}\div 4, 5, 6.$
(4.) $\frac{4}{13}\div 5, 6, 7.$
(5.) $\frac{7}{15}\div 6, 7, 8.$
(6.) $\frac{111}{112}\div 11, 12, 15, 17.$
(7.) $\frac{131}{132}\div 15, 18, 19, 21.$
(8.) $\frac{113}{141}\div 21, 23, 25, 27.$
(9.) $\frac{99}{100}\div 24, 27, 28, 35.$
(10.) $\frac{210}{211}\div 36, 39, 41, 51.$

RULE XLVII.

To reduce an Improper Fraction to a Whole or a Mixed Number.

1°. Divide the numerator by the denominator. The quotient is the whole number. The excess if any will be the numerator and the divisor the denominator of the fraction forming the fractional overplus.

Illustrative Example.—Reduce $\frac{19}{3}$ to a Mixed Number.

$$\begin{array}{r} 3\,\underline{)\,19} \\ 6\tfrac{1}{3}. \end{array} \quad \text{Ans}$$

Exercise 47.

Reduce to mixed numbers:—

(1.) $\frac{141}{8}$; $\frac{1521}{9}$.
(2.) $\frac{1723}{12}$; $\frac{8241}{18}$.
(3.) $\frac{632}{14}$; $\frac{914}{19}$.
(4.) $\frac{42186}{181}$.
(5.) $\frac{321946}{321}$.
(6.) $\frac{415684}{413}$.
(7.) $\frac{789457}{791}$.
(8.) $\frac{3214681}{261}$.
(9.) $\frac{428721}{3256}$.
(10.) $\frac{4128651}{3214}$.

RULE XLVIII.

To reduce a Mixed Number to an Improper Fraction.

1°. Multiply the integer by the denominator; to the product add the numerator, and the sum will be the numerator of the required fraction.

2°. Write the denominator under this numerator, and the result is the answer.

Illustrative Example. — Reduce $41\frac{7}{11}$ to an Improper Fraction.

$$41\tfrac{7}{11} = \frac{41 \times 11 + 7}{11} = \frac{458}{11}. \quad \text{Ans.}$$

Exercise 48.

Express the following mixed numbers as Improper Fractions:—

(1.) $3\frac{1}{6}$; $4\frac{7}{8}$.
(2.) $231\frac{6}{7}$.
(3.) $4896\frac{2}{3}$.
(4.) $6841\frac{11}{12}$.
(5.) $321986\frac{4}{7}$.
(6.) $2132\frac{11}{13}$.
(7.) $86547\frac{13}{15}$.
(8.) $214\frac{141}{168}$.
(9.) $2222\frac{22}{231}$.
(10.) $8888\frac{81}{811}$.

RULE XLIX.

To reduce a Fraction to its lowest terms.

1°. Find the H.C.F. of both terms and divide them by it. The quotients form the respective terms of the required fraction.

Note.—It must be borne in mind that by reducing a fraction to its lowest terms we do not alter its value; *that* remains unchanged. A fraction is said to be in its lowest terms when numerator and denominator are prime to each other, *i.e.* have no common factor.

Illustrative Example.—Reduce $\frac{1562}{3179}$ to its lowest terms.

$$\begin{array}{r|l} 11 & \dfrac{1562}{3179} = \dfrac{142}{289}. \text{ Ans.} \\ 11 & \end{array} \qquad \begin{array}{r|r} 1562 & 3179 \\ \hline 462 & 55 \\ \hline 22 & 11 \\ \hline .. & \end{array}$$

Exercise 49.

Reduce the following fractions to their lowest terms:—

(1.) $\frac{501}{1837}$; $\frac{215}{440}$.
(2.) $\frac{64961}{68419}$; $\frac{384}{672}$.
(3.) $\frac{3330}{5328}$; $\frac{7040}{7392}$.
(4.) $\frac{24389}{26071}$; $\frac{69615}{139308}$.
(5.) $\frac{594}{2079}$; $\frac{377}{403}$.
(6.) $\frac{1892}{1936}$; $\frac{2108}{3813}$.
(7.) $\frac{1919}{2223}$; $\frac{595}{1071}$.
(8.) $\frac{261}{3103}$; $\frac{1547}{5712}$.
(9.) $\frac{114135}{220661}$; $\frac{6398}{7312}$.
(10.) $\frac{100110}{31866}$; $\frac{69615}{92872}$.

RULE L.

To reduce a Compound Fraction to a Simple Fraction in *its lowest or* simplest form.

1°. Reduce any Mixed Numbers to Improper Fractions.

2°. Cancel as far as possible, and then obtain the product of the numerators for the required numerator and of the denominators for the required denominator.

Illustrative Example.—Reduce $1\frac{2}{3}$ of $\frac{5}{6}$ of $8\frac{1}{7}$ of $\frac{42}{125}$ of $\frac{5}{19}$.

First $1\frac{2}{3}=\frac{5}{3}$ and $8\frac{1}{7}=\frac{57}{7}$ ∴ the fraction required is

$$\frac{\cancel{5}\times\cancel{5}\times\cancel{57}\times\cancel{42}\times\cancel{5}}{\cancel{3}\times\cancel{6}\times\cancel{7}\times\cancel{125}\times\cancel{19}}=\frac{1}{1}=1.\quad \text{Ans.}$$

The pupil will see that when *all* the terms of a fraction cancel out the result is 1 or unity, not zero or nought.

Exercise 50.

Reduce the following compound fractions to their simplest forms:—

(1.) $\frac{1}{2}$ of $\frac{2}{3}$ of $\frac{3}{4}$ of $\frac{4}{5}$ of $\frac{5}{6}$.
(2.) $1\frac{2}{3}$ of $2\frac{3}{4}$ of $3\frac{4}{5}$.
(3.) $\frac{4}{5}$ of $\frac{15}{16}$ of $\frac{32}{35}$.
(4.) $4\frac{1}{5}$ of $6\frac{3}{7}$ of $8\frac{5}{6}$.
(5.) $2\frac{2}{3}$ of $3\frac{3}{4}$ of $4\frac{4}{5}$.
(6.) $\frac{6}{7}$ of $\frac{7}{8}$ of $\frac{8}{9}$.
(7.) $4\frac{4}{5}$ of $5\frac{5}{6}$ of $6\frac{6}{7}$ of $7\frac{7}{8}$.
(8.) $\frac{121}{131}$ of $\frac{393}{484}$ of $\frac{655}{726}$.
(9.) $\frac{4}{5}$ of $2\frac{4}{7}$ of $5\frac{8}{9}$ of $8\frac{6}{7}$.
(10.) $41\frac{5}{6}$ of $31\frac{4}{5}$ of $\frac{40}{477}$ of $\frac{36}{1757}$.

Rule LI.

To reduce a series of fractions with different denominators to equivalent ones with the same and the lowest common denominator.

1°. Find the L.C.M. of the denominators, this will be the required denominator.

2°. For the several numerators of the required fractions multiply each numerator by the quotient obtained from the division of the common denominator by its own denominator.

Illustrative Example.—Express $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$, as equivalent fractions having a least common denominator.

Here the L.C.M. of 2, 3, 4, 5 is 60.

Therefore the required fractions are, 1st as to numerators

$$\frac{1\times 60}{2},\quad \frac{2\times 60}{3},\quad \frac{3\times 60}{4},\quad \frac{4\times 60}{5}$$

or 30   40   45   48, and the denominator is 60.

∴ the fractions are $\frac{30}{60}$, $\frac{40}{60}$, $\frac{45}{60}$, and $\frac{48}{60}$.

Exercise 51.

Reduce to equivalent fractions with the L.C. denominator

(1.) $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$.
(2.) $\frac{3}{5}$, $\frac{4}{7}$, $\frac{5}{9}$, $\frac{6}{11}$.
(3.) $\frac{7}{13}$, $\frac{17}{26}$, $\frac{18}{65}$, $\frac{17}{39}$.
(4.) $\frac{1}{17}$, $\frac{3}{34}$, $\frac{5}{51}$, $\frac{16}{85}$.
(5.) $\frac{4}{11}$, $\frac{15}{44}$, $\frac{19}{55}$; $\frac{29}{66}$.
(6.) $\frac{4}{25}$, $\frac{5}{26}$, $\frac{6}{27}$.
(7.) $\frac{17}{18}$, $\frac{18}{19}$, $\frac{19}{20}$.
(8.) $\frac{14}{15}$, $\frac{15}{16}$, $\frac{17}{24}$.
(9.) $\frac{5}{36}$, $\frac{7}{64}$, $\frac{19}{84}$.
(10.) $\frac{3}{161}$, $\frac{15}{92}$, $\frac{141}{230}$.

RULE LII.

To compare the values of each of a series of fractions.

1°. Reduce the fractions according to Rule LI.

2°. Arrange them in ascending or descending order acc ding to their numerators.

Illustrative Example.—Compare the values of $\frac{7}{9}$, $\frac{3}{5}$, $\frac{5}{7}$ in cending order.

L.C.M. of 9 . 5 . 7 = 315, therefore the required denomina is 315.

First numerator = 7 × 5 × 7 = 245.
Second " = 9 × 3 × 7 = 189.
Third " = 9 × 5 × 5 = 225.

Therefore the fractions are in order $\frac{3}{5}$, $\frac{5}{7}$, $\frac{7}{9}$. Ans.

Exercise 52.

Compare the values of the following fractions:—

(1.) $\frac{1}{3}$, $\frac{3}{8}$, $\frac{4}{11}$.
(2.) $\frac{2}{5}$, $\frac{3}{7}$, $\frac{4}{9}$.
(3.) $\frac{13}{14}$, $\frac{15}{16}$, $\frac{20}{21}$.
(4.) $\frac{6}{7}$, $\frac{17}{18}$, $\frac{11}{12}$.
(5.) $\frac{4}{5}$, $\frac{5}{6}$, $\frac{6}{7}$.
(6.) $\frac{9}{11}$, $\frac{7}{9}$, $\frac{11}{13}$.
(7.) $\frac{13}{25}$, $\frac{17}{35}$, $\frac{22}{45}$.
(8.) $\frac{4}{17}$, $\frac{5}{21}$, $\frac{7}{34}$.
(9.) $\frac{3}{16}$, $\frac{4}{21}$, $\frac{5}{26}$.
(10.) $\frac{17}{18}$, $\frac{18}{19}$, $\frac{19}{20}$.

ADDITION, &c., OF VULGAR FRACTIONS.

Rule LIII.

I. To find the sum of two or more fractions.

1°. Reduce any compound fractions to simple ones.

2°. Add any whole numbers separately.

3°. Reduce the fractions according to Rule LI.

4°. Add the numerators, and under the sum place the L.C. denominator. If the resulting fraction be "proper," prefix to it the sum (if any) of the whole numbers for the answer; should the fraction be "improper," reduce it to a mixed number before adding to the integral sum obtained by operation 2°.

Note 1.—In addition it will often be very convenient to group like denominators if labour and time are to be saved.

So much scope for variety of treatment exists in the addition of vulgar fractions, where elegance of method, contraction of work, and economy of material are conspicuous, that to lay down a rigid rule from which there can be no departure is to cramp energy and deprive the pupil of one of the chief charms in his study. One or two questions will therefore be worked in different ways, each mode suggesting some fresh idea or principle.

Note 2.—Never separate the parts of a Compound Fraction. The whole product should invariably be taken.

Illustrative Examples.

Example 1.—Add together $\frac{7}{8}$, $\frac{7}{9}$, $\frac{4}{5}$, $\frac{5}{12}$, and $\frac{17}{24}$.

1st Method (by Rule):—

$$\begin{array}{r|l} 3 & 8 . 9 . 5 . 12 . 24 \\ \hline & 3 . 5 \quad\quad . \ 8 \end{array}$$

L.C.M. of the denominators = 360

∴ the fractions become by Rule LI. case 2°:—

$$\begin{aligned} & \tfrac{7\times45}{360} + \tfrac{7\times40}{360} + \tfrac{4\times72}{360} + \tfrac{5\times30}{360} + \tfrac{17\times15}{360} \\ &= \tfrac{315}{360} + \tfrac{280}{360} + \tfrac{288}{360} + \tfrac{150}{360} + \tfrac{255}{360} \\ &= \tfrac{1288}{360} = 3\tfrac{208}{360} = 3\tfrac{26}{45}. \quad \text{Ans.} \end{aligned}$$

$$\begin{array}{r|r} 360 & 1288 \\ \hline 3 & 208 \end{array}$$

2nd Method (Assimilation):—

First $\frac{5}{12}=\frac{10}{24}$ $\therefore$ $\frac{10+17}{24}=1\frac{1}{8}$, add to this the $\frac{7}{8}$ and we get 2; again $\frac{7}{9}+\frac{4}{5}=\frac{35+36}{45}=1\frac{26}{45}$ $\therefore$ Ans. $=3\frac{26}{45}$.

Or we might have proceeded as follows:—

Break up $\frac{17}{24}$ into $\frac{3}{24}$ and $\frac{14}{24}$; then $\frac{3}{24}=\frac{1}{8}$, add it to $\frac{7}{8}=1$ retain it; $\frac{14}{24}$ we call $\frac{7}{12}$, and add to it the $\frac{5}{12}$ making 1. There is now to add $\frac{7}{9}+\frac{4}{5}=$ as before $1\frac{26}{45}$, and $3\frac{26}{45}$ is the sum.

3rd Method (Incremental):—

$$\tfrac{7}{8}+\tfrac{7}{9}+\tfrac{4}{5}+\tfrac{5}{12}+\tfrac{17}{24}.$$

$$\left.\begin{array}{ll}\text{Here} & \frac{7}{8}=1\sim\frac{1}{8}\\ \text{and} & \frac{17}{24}=1\sim\frac{7}{24}\\ \text{also} & \frac{7}{9}=1\sim\frac{2}{9}\end{array}\right\}\quad \begin{array}{rl}\therefore\ \text{the question is} & (3+\frac{5}{12}+\frac{4}{5})\sim(\frac{7}{24}+\frac{1}{8}+\frac{2}{9})\\ & =(3+\frac{10}{24}+\frac{36}{45})\sim(\frac{10}{24}+\frac{10}{45})\\ & =3\frac{26}{45}.\quad \text{Ans.}\end{array}$$

4th Method (Analytic or Breaking up):—

We shall exhibit this mode at some length, as the principle is a very valuable one; specially so in dealing with large fractions with unwieldy denominators. Facility in Fractional Analysis will materially assist the pupil in subsequent work, and it would prove very advantageous to him were all the questions in this Rule to be solved by each of the methods herein given.

$$\tfrac{7}{8}+\tfrac{7}{9}+\tfrac{4}{5}+\tfrac{5}{12}+\tfrac{17}{24}.$$

$$\begin{gathered}\tfrac{7}{8}=\tfrac{3}{4}+\tfrac{1}{8}:\ \tfrac{7}{9}=\tfrac{28}{36}=\tfrac{3}{4}+\tfrac{1}{36}:\\ \tfrac{4}{5}=\tfrac{16}{20}=\tfrac{3}{4}+\tfrac{1}{20}:\ \tfrac{5}{12}=\tfrac{1}{4}+\tfrac{1}{6}:\\ \tfrac{17}{24}=\tfrac{1}{2}+\tfrac{5}{24}.\end{gathered}$$

And we may write the series of fractions:—

$$\begin{aligned}&\tfrac{3}{4}+\tfrac{3}{4}+\tfrac{3}{4}+\tfrac{1}{2}+\tfrac{1}{4}+\tfrac{1}{6}+\tfrac{1}{8}+\tfrac{1}{20}+\tfrac{5}{24}+\tfrac{1}{36}\\ &=3+\tfrac{1}{2}+\tfrac{1}{20}+\tfrac{1}{36}\\ &=3+\tfrac{11}{20}+\tfrac{1}{36}\\ &=3+\tfrac{396+20}{20\times36}\\ &=3\tfrac{26}{45}.\quad\text{Ans.}\end{aligned}$$

Example 2.—$\frac{11}{12}+\frac{17}{18}+\frac{29}{30}+\frac{47}{48}+\frac{59}{60}$.

1st Method (by Rule):—

$$5.8.9\,\underline{)\,12.18.30.48.60}$$
$$2.$$

$\therefore$ L.C.M. $=2\times5\times8\times9$
$=720$

$\therefore \frac{11}{12}+\frac{17}{18}+\frac{29}{30}+\frac{47}{48}+\frac{59}{60}$

$=\frac{11\times60}{12\times60}+\frac{17\times40}{18\times40}+\frac{29\times24}{30\times24}+\frac{47\times15}{48\times15}+\frac{59\times12}{60\times12}$

$=\frac{660}{720}+\frac{680}{720}+\frac{696}{720}+\frac{705}{720}+\frac{708}{720}$

$=\frac{3449}{720}=4\frac{569}{720}$. Ans.

$$\begin{array}{r|r} 720 & 3449 \\ \hline 4 & 569 \end{array}$$

2nd Method (Incremental and Assimilatory):—
We write the question as below:

$$5\sim\left(\tfrac{1}{12}+\tfrac{1}{18}+\tfrac{1}{30}+\tfrac{1}{48}+\tfrac{1}{60}\right).$$

But $\frac{1}{12}=\frac{5}{60}$ and $\frac{1}{30}=\frac{2}{60}\;\therefore\;\frac{5+2+1}{60}=\frac{8}{60}=\frac{2}{15}$............(*a*).

Again $\frac{1}{18}=\frac{8}{144}$ and $\frac{1}{48}=\frac{3}{144}\;\therefore$ we get $\frac{11}{144}$............(*b*).

Finally $\frac{2}{15}+\frac{11}{144}=\frac{453}{2160}=\frac{151}{720}$ and $5\sim\frac{151}{720}=4\frac{569}{720}$. Ans.

II. To find the difference between any two fractions.

1°. Reduce the fractions to equivalent ones with the L.C. denominator.

2°. Find the difference of the numerators thus obtained.

3°. Place this difference as the numerator of the answer, and underneath write the L.C. denominator.

Note.—Before applying this Rule, compound fractions, if any, must be reduced to simple ones, and all fractions must be in their lowest terms.

Illustrative Examples. — 1. Find the difference between $\frac{176}{297}$ and $\frac{21}{54}$.

First $\frac{176}{297}=\frac{16}{27}$ and $\frac{21}{54}=\frac{7}{18}$.

$\therefore$ the question is $\frac{16}{27}\sim\frac{7}{18}$

L.C. denominator $=54$

and the fractions are $\frac{32}{54}\sim\frac{21}{54}$

$=\frac{11}{54}$. Ans.

2. Find the difference between $\frac{3}{7}$ of $\frac{2}{9}$ of $\frac{4}{5}$ of $7\frac{7}{8}$ and $\frac{3}{44}$ of $2\frac{2}{3}$.

Here $\frac{3}{7}$ of $\frac{2}{9}$ of $\frac{4}{5}$ of $7\frac{7}{8}=\frac{3\times\cancel{2}\times\cancel{4}\times\cancel{63}}{\cancel{7}\times\cancel{9}\times5\times\cancel{8}}=\frac{3}{5}$.

and $\frac{3}{44}$ of $2\frac{2}{3}=\frac{\cancel{3}\times\overset{2}{\cancel{8}}}{\underset{11}{\cancel{44}}\times\cancel{3}}=\frac{2}{11}$

$\therefore$ question becomes $\frac{3}{5}\sim\frac{2}{11}$

$=\frac{33}{55}\sim\frac{10}{55}$

$=\frac{23}{55}$. Ans.

Note.—With the majority of questions in addition of fractions it will be a matter of choice as to which of the methods shall be adopted, but in other cases the course to pursue will be just as obvious, and it may be accepted as a general truth that the "Rule" method will be invariably found the longest, although it may occasionally be profitably combined with others. The pupil will observe that in certain questions the sign *minus* is retained. As such questions are taken from Examination Papers, the presence of the sign is essential to the integrity of the example, but the method of solution is in every case on the incremental or complementary principle.

Exercise 53.

Perform the operations as indicated below:—

(1.) $\frac{1}{2}+\frac{1}{3}+\frac{1}{8}+\frac{1}{24}$.
(2.) $\frac{2}{5}+6\frac{5}{7}+\frac{13}{9}+\frac{8}{21}$.
(3.) $5\frac{1}{3}+\frac{15}{7}+\frac{5}{6}+3\frac{1}{14}$.
(4.) $1\frac{1}{3}+\frac{8}{3}$ of $\frac{41}{34}+\frac{40}{51}$.
(5.) $\frac{7}{12}+2\frac{1}{6}+5\frac{1}{2}$ of $\frac{5}{22}$.
(6.) $17\frac{1}{2}+12\frac{5}{6}+9\frac{1}{3}$.
(7.) $1\frac{1}{2}+2\frac{5}{6}+3\frac{5}{11}+4\frac{7}{33}$.
(8.) $\frac{3}{7}$ of $\frac{5}{12}+\frac{1}{2}$ of $1\frac{9}{14}$.
(9.) $\frac{3}{7}+\frac{5}{8}+\frac{23}{14}+4\frac{1}{4}$.
(10.) $\frac{4}{15}+\frac{5}{8}+\frac{17}{10}+4\frac{5}{6}$.
(11.) $5\frac{4}{9}+\frac{3}{8}+\frac{7}{12}+2\frac{5}{24}$.
(12.) $3\frac{1}{3}+4\frac{3}{8}+2\frac{1}{9}+\frac{9}{12}$.
(13.) $2\frac{3}{7}+5\frac{1}{4}+\frac{8}{21}+1\frac{5}{12}$.
(14.) $\frac{3}{4}+\frac{13}{16}+\frac{13}{32}+\frac{7}{480}$.
(15.) $\frac{7}{16}+\frac{2}{3}+\frac{5}{48}+3\frac{19}{24}$.
(16.) $\frac{2}{3}$ of $\frac{1}{7}$ of $8\frac{3}{4}+\frac{1}{4}$ of $\frac{2}{5}$.
(17.) $\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}$.
(18.) $1\frac{1}{2}+2\frac{1}{3}+3\frac{1}{4}+4\frac{1}{5}+5\frac{1}{6}$.
(19.) $\frac{7}{15}+\frac{9}{17}+\frac{13}{25}+\frac{23}{24}$.
(20.) $7\frac{9}{20}+12\frac{4}{15}+4\frac{7}{12}+\frac{9}{40}+3\frac{7}{10}$.
(21.) $\frac{1}{2}+\frac{2}{3}+\frac{3}{4}+\frac{4}{5}+\frac{5}{6}+\frac{6}{7}$.
(22.) $14\sim12\frac{2}{9}$.
(23.) $16\frac{2}{15}\sim11\frac{7}{18}$.
(24.) $20\frac{1}{4}\sim6\frac{5}{8}$.
(25.) $23\frac{1}{2}\sim10\frac{7}{8}$.
(26.) $4\frac{3}{7}\sim3\frac{3}{4}$.
(27.) $8\frac{4}{5}\sim4\frac{9}{11}$.
(28.) $14\frac{3}{7}\sim5\frac{6}{9}$.
(29.) $10\frac{7}{9}\sim9\frac{7}{10}$.
(30.) $31\frac{5}{8}\sim22\frac{5}{7}$.
(31.) $\frac{1}{3}-\frac{4}{21}+\frac{1}{2}-\frac{7}{11}$.
(32.) $\frac{1}{3}+\frac{1}{5}-\frac{6}{7}+\frac{2}{35}$.
(33.) $1\frac{2}{3}-\frac{6}{8}+\frac{4}{5}-\frac{20}{24}-\frac{2}{5}-\frac{1}{2}$.
(34.) $\frac{3}{8}-\frac{5}{12}+\frac{8}{15}-\frac{3}{20}-\frac{1}{120}$.
(35.) $\frac{1}{2}-\frac{1}{3}+\frac{1}{4}-\frac{1}{5}+\frac{7}{10}$.
(36.) $8\frac{1}{2}-4\frac{2}{3}+\frac{3}{5}-1\frac{1}{6}$ of $\frac{2}{5}$.
(37.) $3\frac{1}{2}-1\frac{7}{8}+4\frac{5}{12}-2\frac{11}{30}$.
(38.) $3\frac{1}{2}+2\frac{1}{12}+3\frac{3}{16}-7\frac{19}{24}$.
(39.) $5\frac{4}{7}+132\frac{132}{133}+17\frac{18}{19}-150\frac{265}{266}$.
(40.) $4\frac{1}{3}-2\frac{1}{6}+5\frac{1}{9}-3\frac{17}{18}+12\frac{5}{36}$.

RULE LIV.

To multiply Vulgar Fractions together.
1°. Reduce any Mixed Number to an Improper Fraction.

2°. Cancel as far as possible.

3°. The product of the unreduced numerators and upper quotients arising from the cancelling will give the required numerator, and the product of the unreduced denominators and lower quotients arising from cancelling will be the required denominator.

4°. If the resulting fraction be "improper" reduce to a Mixed Number.

Illustrative Example.—Multiply $5\frac{7}{9}$ by $8\frac{4}{13}$.

$$5\tfrac{7}{9}=\tfrac{52}{9} \text{ and } 8\tfrac{4}{13}=\tfrac{108}{13}.$$

$$\frac{\overset{4}{\cancel{52}}}{\cancel{9}}\times\frac{\overset{12}{\cancel{108}}}{\cancel{13}}=\frac{48}{1}=48. \text{ Ans.}$$

Exercise 54.

Find the products, as indicated below, in their lowest terms:—

(1.) $14\frac{1}{6}\times 7\frac{1}{17}$.

(2.) $132\frac{4}{5}\times 3\frac{1}{8}$.

(3.) $10\frac{2}{7}\times 2\frac{11}{12}$.

(4.) $\frac{1}{2}\times\frac{3}{2}\times 4\frac{1}{6}$.

(5.) $\frac{5}{7}\times 2\frac{3}{9}\times 1\frac{1}{5}$.

(6.) $\frac{4}{6}\times\frac{5}{7}\times\frac{15}{18}\times\frac{91}{75}$.

(7.) $\frac{1}{2}\times 3\frac{1}{4}\times 5\frac{1}{13}$.

(8.) $4\frac{11}{12}\times 6\frac{10}{59}$.

(9.) $2\frac{3}{5}\times 4\frac{10}{26}$.

(10.) $7\frac{1}{8}\times 11\frac{3}{7}$.

(11.) $\frac{3}{4}\times 3\frac{1}{4}\times 5\frac{1}{3}$.

(12.) $2\frac{1}{2}\times 3\frac{1}{3}\times 4\frac{2}{7}$.

(13.) $\frac{1}{2}\times\frac{3}{7}\times\frac{42}{43}$.

(14.) $\frac{2}{9}\times\frac{3}{10}\times 4\frac{1}{3}\times\frac{45}{78}$.

(15.) $\frac{2}{5}$ of $7\frac{1}{2}\times\frac{1}{8}$ of $11\frac{1}{5}$.

(16.) $\frac{3}{4}$ of $1\frac{5}{11}\times\frac{2}{7}$ of $8\frac{7}{9}$.

(17.) $4\frac{4}{9}\times 2\frac{2}{5}\times 3\frac{1}{4}\times\frac{5}{7}$.

(18.) $3\frac{5}{9}\times 1\frac{7}{8}$ of $\dfrac{1\frac{1}{2}}{5}\times\frac{13}{14}$.

(19.) $\frac{11}{36}\times 11\frac{14}{31}\times 3\frac{18}{25}\times 1\frac{7}{30}$.

(20.) $\frac{7}{90}\times\frac{13}{16}$ of $\frac{15}{17}$ of $\frac{51}{77}\times\frac{99}{100}\times\frac{256}{585}$.

Rule LV.

To divide one fraction by another fraction.

1°. Reduce any Mixed Number to an Improper Fraction.

2°. Invert the divisor, and proceed as in multiplication.

Illustrative Example.—Divide $9\frac{5}{11}$ by $17\frac{3}{22}$.

$$9\tfrac{5}{11}=\tfrac{104}{11} \text{ and } 17\tfrac{3}{22}=\tfrac{377}{22}.$$

$$9\tfrac{5}{11}\div 17\tfrac{3}{22}=\frac{104}{11}\div\frac{377}{22}=\frac{\overset{8}{\cancel{104}}}{\cancel{11}}\times\frac{\overset{2}{\cancel{22}}}{\underset{29}{\cancel{377}}}=\frac{16}{29}. \text{ Ans.}$$

Exercise 55.

Find the various quotients, as indicated, in thei terms:—

(1.) $11\frac{3}{5} \div 4\frac{1}{7}$.
(2.) $5\frac{3}{4} \div 15\frac{1}{3}$.
(3.) $27\frac{12}{15} \div 3\frac{4}{5}$.
(4.) $1\frac{7}{8} \div \frac{3}{4}$.
(5.) $14\frac{4}{9} \div 11\frac{2}{3}$.
(6.) $20\frac{1}{4} \div 2\frac{2}{9}$.
(7.) $11\frac{2}{3} \div 1\frac{3}{4}$.
(8.) $7\frac{5}{18} \div \frac{262}{1080}$.
(9.) $13\frac{7}{11} \div 6$.
(10.) $14\frac{14}{15} \div 2\frac{64}{75}$.
(11.) $6\frac{6}{7}$ of $11\frac{2}{3} \times 1\frac{2}{5} \div 2\frac{2}{5}$.
(12.) $4\frac{2}{9} \times 6\frac{3}{7} \div \frac{2\frac{1}{2}}{7}$.
(13.) $\frac{2\frac{5}{7}}{5} \sim 10\frac{5}{6} \div 1\frac{12}{13} + \frac{3}{7}$ of 3
(14.) $7\frac{3}{4} + \frac{5}{7}$ of $4\frac{2}{3} \div 2\frac{1}{2} \sim 13$
(15.) $3\frac{1}{4} \div (\frac{5}{7}$ of $\frac{6}{13} \times 1\frac{3}{4})$.

RULE LVI.

To find the H.C.F. of a series of Vulgar Fractions.

1^c. Find the H.C.F. of the numerators and the L. the denominators.

2°. Place the former as the numerator and the latte denominator of the required fraction or H.C.F.

Illustrative Example.—Find the H.C.F. or G.C.M $\frac{16}{39}$, and $\frac{28}{65}$.

The H.C.F. of 8, 16, and 28 is 4. } ∴ required H.
The L.C.M. of 13, 39, and 65 = 195. } $= \frac{4}{195}$. Ans

Exercise 56.

Find the H.C.F. of—

(1.) $\frac{14}{15}$ and $\frac{12}{25}$.
(2.) $\frac{12}{19}$ " $\frac{27}{38}$.
(3.) $\frac{14}{15}$ " $\frac{42}{75}$.
(4.) $\frac{18}{23}$ " $\frac{36}{69}$.
(5.) $\frac{14}{15}$ " $\frac{16}{25}$.
(6.) $\frac{3}{16}, \frac{5}{18}, \frac{10}{21}$.
(7.) $\frac{7}{15}, \frac{21}{35}, \frac{35}{45}$.
(8.) $\frac{24}{25}, \frac{36}{55}, \frac{48}{50}$.
(9.) $\frac{13}{14}, \frac{14}{15}, \frac{15}{16}, \frac{16}{17}$
(10.) $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}, \frac{1}{6}$.

RULE LVII.

To find the L.C.M. of a series of Vulgar Fractions.

1°. Take the L.C.M. of the numerators and the H the denominators.

2°. Write the L.C.M. of the numerators as the nur and the H.C.F. of the denominators as the denominato *required* fraction or L.C.M.

Illustrative Example.—Find the L.C.M. of $\frac{4}{5}$, $\frac{7}{10}$, $\frac{9}{20}$.

$$\left.\begin{array}{l}\text{The L.C.M. of 4, 7, and 9 is 252.}\\ \text{The H.C.F. of 5, 10, and 20 is 5.}\end{array}\right\} \quad \therefore \text{required L.C.M.} = \frac{252}{5}.$$

Exercise 57.

Find the L.C.M. of—

(1.) $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$.
(2.) $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$.
(3.) $\frac{4}{5}$, $\frac{7}{10}$, $\frac{9}{15}$, $\frac{10}{49}$.
(4.) $\frac{15}{16}$, $\frac{16}{17}$, $\frac{17}{18}$.
(5.) $\frac{4}{9}$, $\frac{5}{11}$, $\frac{7}{8}$.
(6.) $\frac{24}{25}$, $\frac{1}{30}$, $\frac{12}{35}$, $\frac{27}{40}$.
(7.) $\frac{10}{27}$, $\frac{25}{36}$, $\frac{2}{45}$, $\frac{35}{54}$.
(8.) $\frac{21}{16}$, $\frac{7}{24}$, $\frac{35}{36}$, $\frac{49}{48}$.
(9.) $\frac{32}{33}$, $\frac{48}{55}$, $\frac{64}{77}$, $\frac{32}{66}$.
(10.) $\frac{11}{21}$, $\frac{33}{35}$, $\frac{33}{42}$, $\frac{55}{56}$.

EXERCISES ON COMPLEX FRACTIONS.

As expertness in the manipulation of Complex Fractions is absolutely essential to success in Arithmetic, and as this power can only be acquired by practice, a large and excellent collection of examples is presented for solution, all of which have been prescribed in University, Local, or other Examinations.

Illustrative Example.—Reduce to simple form and in lowest terms the fraction:—

$$\frac{\dfrac{1}{1 \sim \dfrac{1}{2 \sim \frac{1}{2}}} + \frac{1}{3} + (1 + \frac{1}{2})}{3\left(1 + \dfrac{2}{3\frac{1}{2}}\right) \sim 4}.$$

First, $\frac{1}{3} + (1 + \frac{1}{2}) = \frac{1}{3} + 1\frac{1}{2}$
$= 1 + \frac{3}{6} + \frac{2}{6}$
$= 1\frac{5}{6}$.

Second, the lowest term, $3\left(1 + \dfrac{2}{3\frac{1}{2}}\right) \sim 4 = 3(1 + \frac{4}{7}) \sim 4$
$= 3 \times \frac{11}{7} \sim 4 = \frac{33}{7} \sim 4$
$= 4\frac{5}{7} \sim 4$
$= \frac{5}{7}$.

Third, $2 \sim \frac{1}{2} = 1\frac{1}{2} = \frac{3}{2}$

and $\dfrac{1}{\frac{3}{2}} = \frac{2}{3} \therefore 1 \sim \frac{2}{3} = \frac{1}{3}$

and $1 \div \frac{1}{3} = 3$ consequently we have

$$(3 + 1\tfrac{5}{6}) \div \tfrac{5}{7} = 4\tfrac{5}{6} \div \tfrac{5}{7} = \tfrac{29}{6} \div \tfrac{5}{7} = \tfrac{29}{6} \times \tfrac{7}{5} = \tfrac{203}{30}$$
$$= 6\tfrac{23}{30} \text{ Ans.}$$

(1.) $\dfrac{2 + \frac{1}{2} - \frac{1}{3}}{2\frac{1}{3} - 1\frac{1}{4}}$.

(2.) $\frac{38}{39} \times 2\frac{1}{7} \times 2\dfrac{\frac{1}{4}}{4\frac{3}{4}} \div \frac{5}{14}$.

(3.) $5\frac{2}{3}$ of $\frac{1}{15} \div (6\frac{1}{5} - \frac{2}{25})$.

(4.) $\dfrac{3}{8 - \dfrac{7}{2 - \frac{3}{4}}} + \dfrac{5}{6 - \dfrac{5}{2 - \frac{5}{6}}}$.

(5.) $\dfrac{\frac{1}{9} \text{ of } 1\frac{1}{4} \text{ of } 4\frac{1}{2}}{\frac{5}{56} \text{ of } 1\frac{1}{3} \text{ of } 3\frac{1}{2}} - \dfrac{3\frac{1}{4} + 4\frac{1}{3}}{6\frac{1}{2} + 1\frac{1}{12}}$.

(6.) $\dfrac{2\frac{1}{2} + 3\frac{1}{3} - 4\frac{1}{4}}{5\frac{1}{5} + 7\frac{1}{12}}$.

(7.) $\dfrac{4\frac{1}{7} - 2\frac{1}{4}}{6\frac{1}{2} + 2\frac{1}{7}} \div \dfrac{\frac{3}{7} + \frac{1}{2}}{\frac{5}{7} - \frac{1}{2}}$.

(8.) $\frac{18}{17}(1 - \frac{64}{81}) + \frac{8}{11} \times \frac{1}{6} \times \{\frac{1}{2} + \frac{5}{12}\} + \dfrac{1\frac{1}{2} \text{ of } 9\frac{1}{3}}{2\frac{3}{4} \text{ of } 7\frac{7}{11}}$.

(9.) $\frac{7}{12} \times 4\frac{1}{3} - \dfrac{4\frac{1}{4}}{3} + \dfrac{1\frac{3}{5} - \frac{4}{15}}{\frac{2}{3} - \frac{2}{15}} \times \dfrac{5\frac{3}{5}}{9\frac{1}{3}}$.

(10.) $\dfrac{3\frac{1}{2} - 1}{15\frac{1}{3} + 5\frac{1}{2} - 3\frac{1}{3}} \div \dfrac{1 - \frac{3}{4}}{1 + \frac{3}{4}}$.

(11.) $\dfrac{1\frac{4}{17} \times 6\frac{4}{5}}{3\frac{3}{5} - 1\frac{2}{25}} + \frac{2}{11}$ of $(2\frac{2}{5} - \frac{3}{4}) - \dfrac{1\frac{3}{5}}{12}$.

(12.) $3\frac{1}{3} \div \dfrac{1 - \frac{15}{16}}{\frac{1}{5} - \frac{1}{8}}$.

(13.) $\frac{2}{7} \times \dfrac{1 - \frac{2}{7}}{2} + \frac{4}{5} \times \frac{1}{10} + \frac{3}{5}(\frac{1}{2} + \frac{11}{14}) + \frac{3}{7}(\frac{2}{7} + \frac{4}{5})$.

(14.) $\dfrac{3\frac{1}{4} - 2\frac{1}{3}}{3\frac{1}{6} + 1\frac{1}{2}} \div 1\frac{4}{7}$.

(15.) $\dfrac{1}{1 + \dfrac{7}{6\frac{2}{3}}} + \dfrac{7}{13\frac{2}{3}}$.

(16.) $$\dfrac{3}{8-\dfrac{7}{2-\frac{3}{4}}}+\dfrac{5}{6-\dfrac{5}{2-\frac{5}{6}}}.$$

(17.) $$\dfrac{1\frac{3}{5}}{3+\dfrac{1}{3\frac{1}{3}}}+\dfrac{1\frac{2}{3}\text{ of }4\frac{2}{7}}{1\frac{2}{9}\text{ of }3\frac{6}{7}}.$$

(18.) $$\dfrac{5\frac{2}{5}\text{ of }7\frac{2}{9}}{8\frac{7}{24}-3\frac{5}{12}}.$$

(19.) $$\dfrac{\frac{2}{9}\text{ of }1\frac{2}{3}\text{ of }2\frac{2}{5}}{\frac{7}{9}+\frac{5}{12}-\frac{3}{4}}.$$

(20.) $$\dfrac{1\frac{2}{3}+\frac{3}{5}}{\frac{2}{3}\text{ of }2\frac{1}{8}}\times\dfrac{10-7\frac{1}{2}}{3\frac{1}{3}-1\frac{1}{5}}\times 1\tfrac{1}{15}.$$

(21.) $$1+\dfrac{3}{1+\dfrac{3}{1+\frac{1}{2}}}.$$

(22.) $$1\tfrac{1}{6}\text{ of }5\tfrac{1}{4}+\dfrac{4\frac{1}{2}-\frac{3}{10}}{1\frac{1}{15}}-\dfrac{6\frac{3}{4}}{\frac{1}{2}\text{ of }2\frac{2}{3}}.$$

(23.) $$3\tfrac{1}{2}\text{ of }5\tfrac{1}{6}+\tfrac{2}{3}(6\tfrac{1}{4}-2\tfrac{1}{2})-\dfrac{2\frac{1}{6}}{\frac{2}{3}}.$$

(24.) $$2\,\dfrac{\frac{29}{30}-1\frac{19}{45}}{131-\dfrac{943}{7\frac{1}{5}}}-1\tfrac{1}{207}\text{ of }5\tfrac{11}{13}\text{ of }10\tfrac{7}{20}\text{ of }\tfrac{5}{19}\text{ of }\tfrac{1}{16}.$$

(25.) $$\dfrac{\frac{6}{7}+7\frac{3}{4}-6\frac{1}{2}}{2\frac{1}{3}\times 9}.$$

(26.) $$\dfrac{1\frac{2}{3}\text{ of }1\frac{1}{4}}{3\frac{2}{5}+\dfrac{5}{1\frac{19}{41}}}+\dfrac{4}{5+\dfrac{6}{7+\frac{8}{9}}}.$$

(27.) $$(4\tfrac{1}{5}\text{ of }1\tfrac{1}{14}\text{ of }\tfrac{2}{11})\times\dfrac{1\frac{5}{8}-\frac{1}{4}}{3\times\frac{3}{8}}.$$

(28.) $$\dfrac{\frac{1}{2}+\frac{1}{3}-\frac{1}{4}}{\frac{1}{3}+\frac{1}{4}-\frac{1}{5}}\div 1\tfrac{12}{23}.$$

(29.) $$\dfrac{1}{2-\dfrac{3}{4-\frac{5}{6}}}-\dfrac{1}{2+\dfrac{3}{4+\frac{5}{6}}}\times 10\tfrac{5}{9}.$$

(30.) $$\dfrac{1\frac{1}{2}}{4\frac{1}{3}}+\dfrac{3\frac{1}{3}-2\frac{5}{6}}{4\frac{1}{2}+5\frac{9}{10}}+\tfrac{8}{26}\text{ of }5\tfrac{1}{4}.$$

(31.) $$1\tfrac{1}{11}-\dfrac{1-\frac{7}{22}}{2-\frac{1}{3}}+\dfrac{1\frac{2}{5}}{3\frac{1}{2}}-\dfrac{5\frac{5}{8}}{6\frac{1}{4}}\text{ of }\left(\tfrac{1}{5}-\dfrac{\frac{1}{2}-\frac{1}{3}}{4\frac{3}{4}-3\frac{7}{9}}\right).$$

(32.) $\frac{3}{8} \div 6 + \frac{63}{128}$ of $\frac{1}{3}$ of $2\frac{2}{3} + \frac{1}{6\frac{6}{7}} \div \frac{7}{8} + \frac{27}{81}$.

(33.) $\frac{1}{4}$ of $\frac{7}{8}$ of $\left(\frac{2\frac{1}{3}}{3\frac{1}{2}} + \frac{4\frac{1}{2}}{5\frac{1}{4}}\right)$.

(34.) $\frac{\frac{8}{15} + \frac{7}{18} - \frac{17}{105} + \frac{1}{3}}{\frac{11}{30} - \frac{8}{35} + \frac{11}{15}}$.

(35.) $\frac{7\frac{1}{7} - 3\frac{1}{8}}{6 + 4\frac{3}{4}} \div \frac{5\frac{1}{3} + 1\frac{1}{7}}{6\frac{1}{7} - 2\frac{1}{3}}$.

(36.) $\frac{5}{21} \times \frac{13}{15} \times \frac{48}{109} \times \frac{105}{208} \times 21\frac{4}{5}$.

(37.) $\frac{9\frac{1}{4} - 2\frac{7}{10}}{2\frac{3}{4} + 3\frac{4}{5}}$.

(38.) $\frac{(4\frac{1}{2} + 7\frac{1}{3}) \div 3\frac{1}{2}}{\frac{1}{7} \times 2\frac{2}{7} \times 5\frac{1}{4}}$.

(39.) $\frac{1\frac{1}{8}}{1\frac{3}{14}} \div \{(\frac{3}{17} \times 1\frac{1}{2}) - 18\frac{8}{9}\}$.

(40.) $\frac{\frac{1}{2} + \frac{1}{3} + \frac{1}{4}}{\frac{2}{5} + \frac{2}{7} + \frac{2}{9}}$.

(41.) $\frac{\frac{1}{3} + \frac{2}{11} + \frac{7}{24} - \frac{1}{3} \text{ of } \frac{2}{11} \text{ of } \frac{7}{24}}{1 - \frac{1}{3} \text{ of } \frac{2}{11} - \frac{2}{11} \text{ of } \frac{7}{24} - \frac{7}{24} \text{ of } \frac{1}{3}}$.

(42.) $\frac{(\frac{1}{2} + \frac{2}{3}) \text{ of } (\frac{3}{4} + \frac{4}{5}) + (\frac{1}{2} + \frac{3}{4}) \text{ of } (\frac{2}{3} + \frac{4}{5}) + (\frac{1}{2} + \frac{4}{5}) \text{ of } (\frac{2}{3} +}{\frac{1}{2} \text{ of } (\frac{2}{3} + \frac{3}{4} + \frac{4}{5}) + (\frac{1}{2} + \frac{2}{3} + \frac{3}{4}) \text{ of } \frac{4}{5}}$

CROSS OR COMPLEX REDUCTION.

Now that fractions have been fairly grasped, Cross Complex Reduction may profitably be undertaken. So mu useless computation is avoided by the principle of cancelli in the fractional form, that the subject has been reserv until advantage can be taken of so valuable a method. T following rule may be taken as the best for money reducti but miscellaneous questions are not subject to any single r *whatever*, and must be left to the ingenuity of the scholar. *general rule* has been laid down, indeed, but cases arise whe there is *no* denomination common to the two given, and here the rule fails.

Rule LVIII.

To reduce guineas to pounds and pounds to guineas.

1°. Increase the given number by one-twentieth of itself; or reduce the guineas to shillings and divide the result by 20 (for guineas to pounds).

2°. Divide the given number by 21, and add the quotient incrementally to the given number; or reduce the pounds to shillings and divide by 21 (pounds to guineas).

Illustrative Examples.—1. Reduce £8652 to guineas, and 9180 guineas to pounds.

$$\begin{array}{r|r} 21 & 8652 \\ \hline 412 & \underline{25} \\ & 42 \\ & .. \end{array} \qquad \begin{array}{r} 8652 \\ 412 \\ \hline \underline{\underline{8240}}\text{ g's.} \quad \text{Ans.} \end{array} \qquad \begin{array}{r|r} 20 & 9180 \\ & 459 \\ \hline & \underline{\underline{\pounds 9639}}. \quad \text{Ans.} \end{array}$$

2. Reduce 4725 lbs. Troy to tons Avoirdupois weight.

$$\text{The required Answer} = \frac{\overset{27}{\cancel{4725}} \times \overset{9}{\cancel{144}}}{\cancel{175} \times \underset{140}{\cancel{2240}}} \text{ tons}$$

$$= \frac{243}{140} \text{ tons} = 1\tfrac{103}{140} \text{ tons.}$$

Exercise 58.

(1.) Reduce 109375 lbs. Troy to tons Avoirdupois.
(2.) „ £4410 to guineas.
(3.) „ £47628 to moidores.
(4.) „ 5781320 guineas to pounds.
(5.) „ 36841500 „ „
(6.) „ 1050680 „ „
(7.) „ 7766440 „ „
(8.) „ £4580100 to guineas.
(9.) „ £5083911 „
(10.) „ £25419555 „

REDUCTION OF VULGAR FRACTION

RULE LIX.

To reduce one quantity to the fraction of another qua
1°. Write the quantity to be reduced as the numerato
Vulgar Fraction and the other quantity as the denomina
2°. Reduce both terms of this fraction to the same de
nation and express the fraction in its lowest terms.

Illustrative Example.—Reduce 5*s*. $6\frac{1}{2}$*d*. to the fraction o

$$\frac{5s.\ 6\frac{1}{2}d.}{£1,\ 0s.\ 0d.}=\frac{66\frac{1}{2}}{240}=\frac{133}{480}.\quad \text{Ans.}$$

Exercise 59.

Reduce:—

(1.) $5\frac{1}{2}$ gals. to fraction of $1\frac{3}{8}$ pecks.
(2.) 7 oz. „ „ 2 cwts.
(3.) $\frac{1}{9}$ of 2*s*. $7\frac{1}{2}$*d*. „ „ 1 guinea.
(4.) 2 sq. po. 22 yds. „ „ 3 sq. poles.
(5.) 2 ft. 3 in. „ „ $4\frac{1}{2}$ yards.
(6.) $\frac{7}{16}$ of £9, 17*s*. 4*d*. „ „ $9\frac{1}{4}$ guineas.
(7.) 17 yds. 1 ft. $7\frac{1}{2}$ in. „ „ half a mile.
(8.) $2\frac{1}{2}$ gills „ „ $3\frac{1}{3}$ gals.
(9.) $1\frac{1}{2}$ feet „ „ $\frac{1}{4}$ mile.
(10.) $3\frac{3}{4}$*d*. „ „ £1.
(11.) $2\frac{1}{8}$ of £5, 11*s*. 0*d*. „ „ $2\frac{5}{16}$ of £4, 5*s*. 0
(12.) $\frac{3}{4}$ yard „ „ 1 mile.
(13.) $\frac{3}{5}$ of £1, 6*s*. $6\frac{3}{4}$*d*. + $\frac{11}{336}$ of a guinea + $\frac{5}{64}$ of £1.
(14.) $\frac{4}{5}$ of £47, 16*s*. 3*d*. − $\frac{2}{3}$ of £38, 12*s*. 6*d*. to fraction of
(15.) $\frac{5}{3}$ of £1, 13*s*. 9*d*. ~ $\frac{3}{7}$ of £5, 18*s*. 5*d*. to fracti
1 guinea.
(16.) $\frac{12}{91}$ of 13 guineas; $\frac{17}{73}$ of £7, 18*s*. 2*d*.
(17.) $\{\frac{1}{3}(\frac{1}{5}+\frac{5}{2})+\frac{1}{5}(\frac{1}{2}+\frac{2}{3})-\frac{1}{2}(\frac{1}{3}+\frac{3}{5})\}$ of £1.
(18.) $2\frac{2}{5}$ of £$3\frac{3}{4} \div 3\frac{3}{8}$.
(19.) $\frac{7}{8}$ pole + $\frac{3}{8}$ yd. + $\frac{3}{16}$ foot.
(20.) $\frac{1}{4}\left(\frac{4\frac{7}{9}\text{ of }6\frac{2}{3}}{7\frac{26}{27}}\right)\times\frac{17}{18}\left(\frac{3\frac{1}{7}\text{ of }18\frac{3}{8}}{6\frac{1}{9}\text{ of }9\frac{6}{11}}\right)$ £.

DECIMAL FRACTIONS.

The word *decimal* means "of or pertaining to tens," and Decimal Fractions are those whose denominators (not expressed, but only indicated) are ten or some power of ten. Decimal Fractions are obtained by continuing digits on to the right of the unit figure. Every figure in an ordinary integral number is ten times the value of the same figure in the next right-hand place, and is also one-tenth of the value of the same figure in the next left-hand place; therefore, if the units place be fixed, the digit immediately to the right of it must be tenths of units, the next right-hand figure tenths of tenths or hundreds of units, and so on.

A dot called the point, or the decimal point, is placed before the figures belonging to or composing a decimal fraction to show that the quantity is fractional, and it is also used to divide a decimal fraction from an accompanying integer, thus 123·45 is read one hundred and twenty-three, point (or decimal) four, five, and means the sum of one hundred units, twenty units, three units, four-tenths of units, and five-hundredths of units. Decimals enter into so many departments of higher mathematics, and their use is so general, that their importance can hardly be over-estimated.

RULE LX.

To reduce Vulgar Fractions to Decimal Fractions.

1°. Divide the numerator by the denominator affixing ciphers as required.

Illustrative Example.—Reduce $\frac{5}{16}$ to a Decimal Fraction.

$$\begin{array}{r|l} 16 & 5\cdot0000 \\ \hline \text{Ans.} = \cdot3125 & \underline{20} \\ & \;\underline{40} \\ & \;\;\underline{80} \\ & \;\;\;\cdot\,\cdot \end{array}$$

Exercise 60.

xpress each of the following fractions as a Decimal:—

(1.) $\frac{3}{10}$; $\frac{7}{10000}$; $\frac{12}{10000000}$.
(2.) $\frac{26}{65}$; $\frac{18}{125}$.
(3.) $\frac{125}{256}$.
(4.) $\frac{131}{625}$.
(5.) $\frac{375}{512}$.
(6.) $\frac{8145}{10000}$.
(7.) $\frac{3675}{4096}$.
(8.) $\frac{3584}{4375}$.
(9.) $\frac{512}{100000000}$.
(10.) $\frac{13125}{14336}$.

Rule LXI.

To reduce Decimals to Vulgar Fractions.

1°. Place the given decimal, without the decimal point, as the numerator of the required fraction.

2°. For the denominator write unity (1) with as many ciphers following as there were decimal places in the original decimal fraction, and then reduce to lowest terms.

Illustrative Example. — Reduce ·00125 to its equivalent Vulgar Fraction.

$$\frac{\overset{1}{\cancel{125}}}{\underset{800}{\cancel{100000}}} = \frac{1}{800}.\quad \text{Ans.}$$

Exercise 61.

Reduce to their equivalent Vulgar Fractions:—

(1.) ·0875; ·875.
(2.) ·325; ·00325.
(3.) ·3125; ·0125.
(4.) ·625; ·00625.
(5.) ·006125; ·6225.
(6.) ·0000875; ·00252.
(7.) ·0000000375; ·0006
(8.) ·7875; ·00008.
(9.) ·001125; ·0000756
(10.) ·00008364; ·0000

Rule LXII.

To add Decimal Fractions together.

1°. Write the quantities under each other as in addition of integers, the decimal point being kept ve related.

2°. Add as in ordinary numbers, and place the decir *vertically* under the decimal points in the addends.

Illustrative Example.—Add together 4·006; 353·1; ·00018; and 57.

```
   4·006
 353·1
    ·00018
  57
 ─────────
 414·10618.   Ans.
```

Exercise 62.

Add the following Decimals as indicated:—

(1.) 125·3 + 29·024 + ·09063 + 671.
(2.) 3·507 + ·0036 + 418·8 + 96.
(3.) 17·493 + 2·574 + 125 + ·004270.
(4.) 15·0102 + ·004 + 20 + ·86280.
(5.) ·00125 + 14·473 + 12500 + ·0032.
(6.) 58 + ·099 + 99·7665 + 36·77 + 34·096.
(7.) 17·73 + 5796·0454 + 99 + 19·08 + 365·7.
(8.) 66·7 + 395·486 + 4796·5438 + ·79 + 58.
(9.) ·04597 + ·486 + 43·9 + 93 + 45·67 + 9·8.
(10.) 38·89654 + ·97 + 19·65 + 46 + 64·0795.
(11.) 479·978 + 98 + ·093 + ·5796 + 36940 + 17·19.
(12.) 391·41 + ·00861 + 22·222 + 1406·03215 + 80.
(13.) 71·456002 + 16841 + ·01234567 + 66·666.
(14.) 895·32157 + 89·532157 + ·89532157 + 89532·2157.
(15.) 7654·321 + ·7654321 + 76543·0021 + 76·54321.

RULE LXIII.

To find the difference between any two Decimal Fractions.

1°. Arrange as in Rule LXII., writing the smaller quantity below the greater.

2°. Incrementally add according to Rule IV., placing the decimal point as in Rule LXII. 2°.

Illustrative Example.—Find the difference between 14·0015 and 8·904701.

```
 14·001500
  8·904701
 ─────────
  5·096799.   Ans.
```

Exercise 63.

Find the differences as indicated:—

(1.) 42·17 ∼ 3·6592.
(2.) 86·1 ∼ 37·589.
(3.) 129·068 ∼ 5·64723.
(4.) 47·132 ∼ 46·25107.
(5.) 8·314 ∼ 2·9876543.
(6.) 146·5 ∼ ·00086945.
(7.) 32·041 ∼ 31·98765.
(8.) 11842·6 ∼ 9988·776604.
(9.) 231 ∼ ·0080014.
(10.) 1 ∼ ·001101.
(11.) ·1 ∼ ·000999.
(12.) ·001 ∼ ·0009009.
(13.) 3·004 ∼ 3·0039001.
(14.) 5000 ∼ ·736001.
(15.) 10000 ∼ ·00081452.

RULE LXIV.

To multiply Decimal Fractions together.

1°. Place the quantities as in integral multiplication, and multiply also as in that rule.

2°. Mark off in the product as many decimal places as there are in the multiplier and multiplicand taken together, prefixing ciphers if necessary.

Illustrative Example.—Multiply 13·615 by ·00153.

$$\begin{array}{r} 13\cdot615 \\ \underline{\cdot00153} \\ 40845 \\ \underline{204225} \\ \underline{\underline{\cdot02083095.}} \end{array} \quad \text{Ans.}$$

Note.—It will afford good practice to the scholar if all the examples in this rule be reduced to Vulgar Fractions, the multiplication performed, and the results reduced back to Decimal Fractions. Most if not all the contractions given in the elementary rules will be more or less available in the several rules under Decimal Fractions.

Exercise 64.

Multiply the following Decimals as directed:—

(1.) 3·714 × 28·7.
(2.) 6 × ·0005.
(3.) *57·013* × ·00029.
(4.) 34·203 × ·0123.
(5.) ·008 × ·0016.
(6.) ·0125 × 20·08.

(7.) ·02057 × ·0039.
(8.) ·47 × ·00432.
(9.) ·575 × 2·04.
(10.) ·36 × ·00828.
(11.) ·00202 × 2·02.
(12.) 1·00025 × 2400.
(13.) 1·08 × ·007.
(14.) 35·6 × ·01094.
(15.) ·003105 × 36·4.
(16.) 2·1825 × ·0046.
(17.) ·003625 × 74·2.
(18.) 35·85 × 2·09.
(19.) 3·585 × ·00209.
(20.) ·003125 × ·48.
(21.) 8·4 × ·009.
(22.) 3·753 × 9·08.
(23.) ·0204 × 40·2.
(24.) ·01 × ·001.
(25.) ·00125 × 640000.
(26.) ·00012 × ·00013.
(27.) 500 × ·000000081.
(28.) ·000003 × ·0000401.
(29.) ·001 × ·0001 × ·0002.
(30.) ·003 × ·0004 × ·000501.

RULE LXV.

To perform contracted multiplication of Decimals.

1°. Mark off from the decimal point in the multiplicand as many decimal places as it is required to have in the answer—adding ciphers if necessary. To ensure accuracy in the last decimal place it is necessary to take one more decimal place in the multiplicand.

2°. Under the extreme right-hand figure of these place the unit figure of the multiplier, and write the other figures of the multiplier in the reverse order.

3°. Beginning with the right-hand figure of the multiplier, multiply by each digit of the multiplier, neglecting all the multiplicand figures to the right of the multiplying figure in use for the time being except for carrying.

4°. Let all the products be so written that their right-hand figures may be vertically under each other.

5°. In the product mark off the required number of decimal places.

Illustrative Example.—Multiply 3·00704 by 4·0205 correct to 4 places. In order to be correct we take it to 5 places.

$$\begin{array}{r} 3{\cdot}00704 \\ 50204 \\ \hline 1202816 \\ 6014 \\ 150 \\ \hline \underline{\underline{12{\cdot}0898\cancel{0}}}. \end{array} \quad \textbf{Ans.}$$

Exercise 65.

Perform the multiplication and retain four places of d mals.

(1.) 13·734 × 9·105.
(2.) 219·352 × ·00513.
(3.) 84·723 × 7·05.
(4.) 17·061 × ·050328.
(5.) ·3721 × ·40107.
(6.) 191·191 × ·3651.
(7.) 1·00123 × 1·165.
(8.) 71·0013 × ·010303.
(9.) 947·36 × ·00423.
(10.) 46·2375 × 4·00743.
(11.) 34·0069 × ·005006.
(12.) 5·415 × 3·375.
(13.) 8·90901 × ·0031.
(14.) 2·456 × ·00517.
(15.) ·8605 × ·5041.
(16.) ·1234 × ·4321.
(17.) ·0123 × 5·432.
(18.) ·1111111 × ·1111111
(19.) 513·411 × 6·8011.
(20.) ·5354 × ·00053.

Rule LXVI.

To divide one Decimal by another.

1°. Equalize the number of decimal places in the div and dividend by the addition of ciphers, and throw out decimal points.

2°. Any division that can now take place will give integral quotient, and should no division be possible cipl must be added to the dividend (or struck out of the divis the decimal point being placed in the quotient when the f cipher is brought down or struck out in the divisor.

Illustrative Example.—Divide 4·1065 by 33·41.

$$\begin{array}{lr|r} & 33\cdot4100 & 4\cdot1065 \\ & 3341\cancel{0}\cancel{0} & 41065 \\ \cline{2-3} \text{Ans.} & \cdot1229+ & 7655 \\ & & 9730 \\ & & 30480 \\ & & 411 \end{array}$$

Exercise 66.

Perform the operations as indicated:—

(1.) ·0169 ÷ ·013.
(2.) 49·7 ÷ ·0025.
(3.) ·00003 ÷ ·001.
(4.) 68·8085 ÷ 1·5.
(5.) ·060248 ÷ 27·2.
(6.) 17·25 ÷ ·0023.

(7.) 30·5118 ÷ 50·6.
(8.) 56·673 ÷ ·0021.
(9.) 36 ÷ ·012.
(10.) ·36 ÷ 12·0.
(11.) 3·6 ÷ 1·2.
(12.) 84·375 ÷ ·00375.
(13.) 21·97 ÷ 1·69, ·169, 1690.
(14.) ·144 ÷ 1200.
(15.) 4·8 ÷ ·0016.
(16.) 1126·08 ÷ ·00276.
(17.) ·36 ÷ ·00828.
(18.) ·0216 ÷ 25; 1·5 ÷ ·0064.
(19.) 3·75 ÷ 225000.
(20.) 36 ÷ ·0081.
(21.) 3075 ÷ ·125.
(22.) 1215013·8 ÷ 2·023.
(23.) ·000072072 ÷ ·000012.
(24.) 6·82 ÷ ·0125.
(25.) 3·12 ÷ 325; 312 ÷ ·0325.
(26.) 64 ÷ ·08; 6·4 ÷ 80; ·064 ÷ ·008.
(27.) ·024 ÷ 60; 24 ÷ ·006; 2·4 ÷ ·06.
(28.) 1·69 ÷ ·013; 16·9 ÷ 13; 169 ÷ 1·3.
(29.) 1·44 ÷ 1·2; 144 ÷ ·6; ·144 ÷ ·016.
(30.) 16 ÷ ·002; ·002 ÷ 1·6.
(31.) 5·31682 ÷ ·2.
(32.) ·00000512 ÷ ·08.
(33.) ·00000729 ÷ 270.
(34.) ·0004851 ÷ 330000.
(35.) 4851 ÷ ·000000033.
(36.) ·000001089 ÷ ·0011.
(37.) 1089 ÷ ·00000000011.
(38.) ·0000000016 ÷ 4000.
(39.) 913·624 ÷ 2·28406.
(40.) ·6395368 ÷ 228406.

Rule LXVII.

To perform division of Decimals by a contracted method, having any required number of decimal places in the quotient.

1°. Obtain the first quotient figure and determine its position decimally.

2°. Continue the division until the number of figures remaining to be found is less than the number of figures in the divisor.

3°. Instead of adding ciphers to the dividend cut off a figure from the divisor, simply carrying from the figure dropped.

4°. Repeat the cutting off until no figures remain.

Illustrative Example.—Divide 91·6 by 8931·61 to places.

$$\begin{array}{rr|r} & \underline{8931\cancel{6}\cancel{1}} & \underline{916000} \\ \text{Ans.} & \cdot0102 & \underline{22839} \\ & & \underline{\underline{4976}} \end{array}$$

Exercise 67.

Perform the divisions as indicated:—

$$\left.\begin{array}{ll} (1.) & 834{\cdot}06 \div 51{\cdot}8724 \\ (2.) & 1234{\cdot}5 \div {\cdot}34567 \\ (3.) & 45{\cdot}67 \div 2{\cdot}9876 \\ (4.) & 54321 \div 7893{\cdot}124 \\ (5.) & 7{\cdot}2894 \div 81{\cdot}31256 \\ (6.) & 519{\cdot}683 \div 9876{\cdot}5431 \\ (7.) & 21{\cdot}09274 \div {\cdot}8677521 \\ (8.) & 3{\cdot}014 \div 71{\cdot}5215 \\ (9.) & 810{\cdot}325 \div 6{\cdot}91237 \\ (10.) & 24{\cdot}36705 \div 9{\cdot}87654 \end{array}\right\} \text{To four places of decimals.}$$

REPEATING DECIMALS.

All Vulgar Fractions may be reduced to the decimal f but all Vulgar Fractions cannot be accurately expresse decimals. If we attempt to reduce $\frac{3}{8}$ to a Decimal we get and the division as well as the decimal terminates; we ·375, therefore, a Finite or Terminating Decimal. But i attempt to reduce $\frac{3}{7}$ to the decimal form we then ·428571428571, &c., and the division will never termin that is, a Repeating, Indeterminate, or Circulating Decim the result of our work. These circulating decimals are ei pure or mixed: pure when the repetend (or repeating pe includes the first decimal figure or digit, and mixed when repetend commences at the second or any subsequent fi of the decimal. Although the accurate and absolute val a *Vulgar* Fraction whose denominator contains factors c han 2 or 5 cannot be actually given in the decimal form, yet the decimal may approximate to this true value as nearly as we please, *e.g.*, whilst $\frac{3}{7}$ as above represented by $\cdot\dot{4}2857\dot{1}$ (where the points above the extreme digits of the repetend indicate the repeating period or portion) is not quite exact, we may go as near as we please by continuing the figures, so far, indeed, that the difference shall be utterly inappreciable. The repetend may be indicated either by the dot, as above explained, or by the dash, as $\cdot\acute{4}2857\acute{1}$.

RULE LXVIII.

To reduce a pure Repeater to its equivalent Vulgar Fraction.

1°. Write the given Decimal as the numerator of the required fraction, and for the denominator write as many nines as there are decimal places.

2°. Reduce the fraction to its lowest terms.

Illustrative Example.—Reduce $\cdot\dot{1}2345\dot{6}$ to its equivalent Vulgar Fraction.

$$\frac{123456}{999999}=\frac{41152}{333333}.\quad \text{Ans.}$$

Exercise 68.

Reduce to equivalent Vulgar Fractions in their lowest terms:—

(1.) $\cdot\dot{0}057\dot{8}$; $\cdot\dot{3}6\dot{7}$.

(2.) $\cdot\dot{8}$; $\cdot\dot{6}$; $\cdot\dot{5}14\dot{0}$.

(3.) $\cdot\dot{3}21\dot{4}$; $\cdot\dot{1}298\dot{7}$.

(4.) $\cdot\dot{7}82\dot{1}$; $\cdot\dot{3}8\dot{7}$.

(5.) $\cdot\dot{1}238\dot{4}$; $\cdot\dot{7}3\dot{8}$.

(6.) $\cdot\dot{1}234567\dot{8}$.

(7.) $\cdot\dot{4}321567\dot{8}$.

(8.) $\cdot\dot{3}04050\dot{6}$.

(9.) $\cdot\dot{0}04500\dot{9}$.

(10.) $\cdot\dot{0}1020\dot{3}$.

RULE LXIX.

To reduce a Mixed Repeater to its equivalent Vulgar Fraction.

1°. Find the difference between the whole decimal and the non-repeating part thereof by incremental addition.

2°. Write the difference thus obtained as the numerator of the required fraction, and for the denominator write as nines as there are repeating figures in the decimal, a many ciphers after them as there are non-repeating figu

3°. Reduce to the lowest terms.

Illustrative Example.—Reduce $\cdot 2\dot{6}1\dot{5}$ to its equivalent Fraction.

$$\begin{array}{rl} 2615 & = \text{whole decimal} \\ 2 & = \text{non-repeating part} \\ \hline 2613 & = \text{difference} \end{array} \qquad \frac{2613}{9990} = \frac{871}{3330}.$$

Exercise 69.

Reduce to Vulgar Fractions in their lowest terms:—

(1.) $\cdot 011\dot{3}\dot{6}$.

(2.) $\cdot 31\dot{4}\dot{5}$.

(3.) $\cdot 005\dot{1}6\dot{5}$.

(4.) $\cdot 3210\dot{1}2\dot{3}$.

(5.) $\cdot 12\dot{1}21\dot{3}$.

(6.) $\cdot 5432\dot{1}$; $\cdot 5700\dot{3}$

(7.) $\cdot 4321\dot{5}$; $\cdot 9100\dot{3}$

(8.) $\cdot 32\dot{0}1\dot{4}$; $\cdot 21\dot{3}40$

(9.) $\cdot 32\dot{1}00\dot{4}$; $\cdot 7121$

(10.) $\cdot 037\dot{1}\dot{5}$; $\cdot 21\dot{2}34$

Note.—The following demonstration will fully expla principles involved in Rules LXVIII. and LXIX.

To show the value of $\cdot\dot{2}61\dot{5}$ (a Pure Circulator)—

$$\begin{array}{lrl} \text{Let} & x & = \cdot\dot{2}61\dot{5} \\ \text{then} & 10{,}000\,x & = 2615\cdot 26152615 + \\ \text{and} & 1\,x & = \quad\;\; \cdot 26152615 + \\ \hline & \therefore 9999\,x & = 2615\cdot 00000000 \end{array}$$

or $x = \frac{2615}{9999}$, which is the answer ob by the Rule.

To show the value of $\cdot 2\dot{6}1\dot{5}$ (a Mixed Circulator)—

$$\begin{array}{lrl} \text{If} & x & = \cdot 2\dot{6}1\dot{5} \\ \text{then} & 10{,}000\,x & = 2615\cdot 615615 + \\ \text{and} & 10\,x & = \quad\;\; 2\cdot 615615 + \\ \hline & \therefore 9990\,x & = 2613\cdot 000000 \end{array}$$

wherefore $x = \frac{2613}{9990}$, which is the answer ously obtained by

RULE LXX.

To find the sum of a series of repeating decimals, or to find the difference between two circulating decimals.

1°. Place the decimals exactly as in addition of Finite Decimals, continuing the figures as far to the right as is required, and perform the addition precisely as in Rules LXII. and LXIII.

Illustrative Examples.—1. Find the sum of $1{\cdot}50\dot{1}2\dot{3}$, ${\cdot}3\dot{0}14\dot{5}$, ${\cdot}0005\dot{1}47\dot{8}$, $4{\cdot}3\dot{4}$, and ${\cdot}8\dot{1}\dot{5}$.

Here the L.C.M. of the numbers of figures in the various repetends 1, 2, 3, 4 is 12. We must, therefore, in order to get the repetend of the sum carry the several decimals twelve places from the longest finite part in any one of them, and the result is

$$\begin{array}{r}
1{\cdot}500\dot{1}2\dot{3}12312312312 \\
{\cdot}3\dot{0}14\dot{5}014501450145 \\
{\cdot}0005\dot{1}47\dot{8}147814781 \\
4{\cdot}3\dot{4}444444444444444 \\
{\cdot}8\dot{1}\dot{5}151515151515 \\
\hline
6{\cdot}961684\dot{0}09211731\dot{9}
\end{array}\quad \text{Ans.}$$

2. Find the difference between $3{\cdot}14\dot{5}0\dot{1}$ and ${\cdot}67\dot{2}\dot{4}$.

$$\begin{array}{r}
3{\cdot}14\dot{5}0\dot{1}501 \\
{\cdot}67\dot{2}\dot{4}2424 \\
\hline
2{\cdot}47\dot{2}5907\dot{7}.
\end{array}\quad \text{Ans.}$$

Exercise 70.

Perform the operations indicated true to six places of decimals:—

(1.) $3{\cdot}\dot{1}45\dot{6} + 214{\cdot}78\dot{9}0\dot{1} + 32{\cdot}90\dot{8}\dot{7} + 2157 + {\cdot}\dot{1}$.

(2.) $6{\cdot}\dot{2}91\dot{2} + 36{\cdot}72\dot{4}5\dot{2} + 14{\cdot}32\dot{5} + 1{\cdot}\dot{4}$.

(3.) $153{\cdot}145\dot{6} \sim 49{\cdot}8432\dot{1}0\dot{6}$.

(4.) $72{\cdot}\dot{5}4\dot{6} + 815{\cdot}\dot{1} + 36{\cdot}045\dot{6}\dot{7}$.

(5.) $90\cdot003\dot{7}4\dot{6} \sim 20\cdot4057\dot{9}8\dot{9}$.

(6.) $142\cdot\dot{5} + 32\cdot0\dot{6}\dot{7} \sim 24\cdot847\dot{6}\dot{2} + 9\cdot8321\dot{9}$.

(7.) $6\cdot004\dot{1}\dot{5} \sim 1\cdot8005\dot{7}$.

(8.) $4\cdot\dot{5} + 7\cdot\dot{6} + 8\cdot\dot{9} + 9\cdot1\dot{3} + 4\cdot5\dot{1}\dot{6}$.

(9.) $2\cdot\dot{0}\dot{1} + 30\cdot\dot{5}0\dot{6} + 5\cdot\dot{7}00\dot{8} + 9\cdot\dot{4}000\dot{3}$.

(10.) $\cdot\dot{9} + \cdot\dot{8} + \cdot\dot{7} + \cdot\dot{6} + \cdot\dot{0}\dot{9} + \cdot\dot{0}0\dot{8} + \cdot\dot{0}00\dot{7} + \cdot\dot{0}000\dot{6}$.

RULE LXXI.

To multiply or divide Repeating Decimals.

1°. Reduce to Vulgar Fractions; perform the multiplic or the division; reduce the fraction to a decimal.

Illustrative Example.—Multiply $5\cdot\dot{3}$ by $\cdot03\dot{6}$ and di $17\cdot\dot{5}$ by $4\cdot\dot{3}\dot{1}$.

$$5\cdot\dot{3} = 5\tfrac{3}{9} = 5\tfrac{1}{3} = \tfrac{16}{3};\ \cdot03\dot{6} = \tfrac{36\sim3}{900} = \tfrac{33}{900} = \tfrac{11}{300}.$$

$$\therefore\ \tfrac{16}{3} \times \tfrac{11}{300} = \tfrac{176}{900} = \underline{\underline{\cdot19\dot{5}}} \qquad \text{Ans.}$$

$$\begin{array}{r|l} 9\cancel{0}\cancel{0} & \underline{176} \\ \cdot19\dot{5} & \underline{86} \\ & \underline{50} \\ & 5 \end{array}$$

Again $\quad 17\cdot\dot{5} = 17\tfrac{5}{9} = \tfrac{158}{9};\ \ 4\cdot\dot{3}\dot{1} = 4\tfrac{31}{99} = \tfrac{427}{99}.$

$$\therefore\ \tfrac{158}{9} \div \tfrac{427}{99} = \frac{158}{\cancel{9}} \times \frac{\overset{11}{\cancel{99}}}{427} = \tfrac{1738}{427} = \underline{\underline{4\cdot070257611+}}$$

$$\begin{array}{r|l} 427 & \underline{1738} \\ 4\cdot070257611 & \underline{3000} \\ & \underline{1100} \\ & \underline{2460} \\ & \underline{3250} \\ & \underline{2610} \\ & \underline{480} \\ & 530 \end{array}$$

Exercise 71.

Perform the operations indicated below, to not more than six places of decimals:—

(1.) $4\cdot2\dot{6} \div \cdot7\dot{3}$.

(2.) $\cdot\dot{3} \times \cdot\dot{0}2\dot{1}$ (answer in Recurring Decimals).

(3.) $\cdot15\dot{9}\dot{0} \times \cdot47\dot{2} \div 2\cdot\dot{7}$.

(4.) $27\cdot36 \div 3\cdot1\dot{0}\dot{9}$.

(5.) $2\cdot8 \times 11\cdot\dot{3}\dot{6} \div 5\cdot6\dot{8}\dot{1}$.

(6.) $\cdot\dot{0}1\dot{2} \times \cdot\dot{3}9\dot{6} \times 16\cdot65$.

(7.) $3\cdot\dot{2}8571\dot{4} \times \cdot\dot{3}8461\dot{5}$.

(8.) $\cdot\dot{0}8\dot{1} \times \cdot925$.

(9.) $\cdot068\dot{1} \div 5\cdot4\dot{5}$.

(10.) $\cdot\dot{3}4\dot{5} \times \cdot333 \div 4\cdot3$.

REDUCTION OF DECIMALS.

In the solution of questions under this heading, one or two suggestions may be helpful to the pupil. First let it be remembered that the sign of multiplication must be substituted for the word "of" in both Vulgar and Decimal Fractions. Second, that in such questions as, "Find the value of ·815 of £5," we may substitute for the £5 its equivalent in farthings, then perform the multiplication and reduce the integral portion of our result up to pence, shillings, and pounds. However, it may be found more convenient in these cases to multiply the decimal in our question, say by 5 (marking off the integral part as pounds); multiplying by 20 (marking off the integral part as shillings); then multiplying by 12 (marking off the integral portion as pence); and lastly, multiplying by 4 for the farthings. Instead of prescribing a rule, or several rules, three or four questions will be worked in full with all needful explanations; but in complex reduction of both Vulgar and Decimal Fractions much is necessarily left to the resources of the worker, and much more will depend upon the thoroughness with which the preceding rules have been studied.

Illustrative Examples.—1. Find the value of ·875 of 6*s.*

$$\begin{array}{l} \cdot875 \\ \quad 80d. = 6s.\ 8d. \\ \hline 70{,}000 \end{array}$$

$$\therefore \text{ Ans.} = 70d. = 5s.\ 10d.$$

2. Reduce £1, 17*s.* 6*d.* to decimal of £5. As in Vu Fractions we say—

$$\text{the question} = \frac{\overset{\pounds}{1}\ \ \overset{s.}{17}\ \ \overset{d.}{6}}{5\ \ \ 0\ \ \ 0} = \frac{1\frac{7}{8}}{5} = \frac{15}{40} = \frac{3}{8} = \underline{\underline{\cdot375.}} \quad \text{Ans.}$$

3. Reduce 8 oz. to decimal of 2 cwts.

$$\text{question is } \frac{8 \text{ oz.}}{2 \text{ cwts.}} = \frac{8}{2 \times 112 \times 16} = \frac{1}{448} = \underline{\underline{\cdot00225 + .}} \quad \text{Ans}$$

$$\begin{array}{r|l} 448 & 1000 \\ \hline \cdot00225 & \ \ 1140 \\ & \ \ \ 2440 \end{array}$$

4. Reduce the sum of ·375 of a guinea, $\cdot\dot{5}\dot{4}$ of 8*s.* 3*d.*, and · of £2, 15*s.* to the decimal of £1, 14*s.* 8¼*d.*

$$\cdot375 \text{ of a guinea} = \frac{\overset{3}{\cancel{375}} \times \overset{63}{\cancel{252}}}{\underset{\underset{2}{\cancel{250}}}{\cancel{1000}}}d. = \frac{189}{2}d. = 94\tfrac{1}{2}d.$$

$$\cdot\dot{5}\dot{4} \text{ of } 8s.\ 3d. = \frac{54}{99} \times \frac{99}{1}d. = 54d.$$

$$\cdot0\dot{2}\dot{7} \text{ of } \pounds2,\ 15s. = \frac{\overset{3}{\cancel{27}}}{\underset{\underset{2}{\cancel{18}}}{\cancel{990}}} \times \frac{\cancel{55}}{1}s. = 18d.$$

$$\begin{aligned} \therefore \text{ sum of quantities} \quad &= (94\tfrac{1}{2} + 54 + 18)d. \\ &= 166\tfrac{1}{2}d. \\ &= 666 \text{ farthings} \\ \textit{Also } \pounds1,\ 14s.\ 8\tfrac{1}{4}d. \quad &= 1665 \quad \text{,,} \end{aligned}$$

$$\therefore \text{ required decimal} = \frac{\overset{\overset{2}{\cancel{222}}}{\cancel{666}}}{\underset{\underset{5}{\cancel{555}}}{\cancel{1665}}} = \frac{2}{5} = {\cdot}4. \quad \text{Ans.}$$

or

$$\begin{array}{r|l} 1665 & \underline{6660} \\ \text{Ans.}\quad \overline{{\cdot}4} & \;\ldots\ldots \end{array}$$

RULE LXXII.

To write down any number of shillings, pence, and farthings as the decimal of a pound sterling.

1°. Allow 100 for every 2 shillings and 50 for the odd one (if it be given) and a unit for each farthing in the pence and farthings, increasing this last result by 1 if the pence exceed 5*d.*

2°. Make 3 decimal places of the sum.

Or (the usual rule presented for this work is):—

1°. Divide the farthings by 4.

2°. Prefix the pence and divide the result by 12.

3°. Prefix the shillings to the last quotient and divide by 20.

Note.—For all practical purposes the first method is sufficient, but where absolute accuracy to the last digit is demanded, the second method must be employed.

Illustrative Example.—Reduce 17*s.* 11¾*d.* to the decimal of a pound sterling.

$$\begin{array}{r|l} 4 & \underline{3} \\ 12 & \underline{11{\cdot}75} \quad \text{(By second method.)} \\ 20 & \underline{17{\cdot}9791\dot{6}} \\ & \underline{\underline{{\cdot}898958\dot{3}.}} \quad \text{Ans.} \end{array} \qquad \begin{array}{r} 850 \\ \underline{48} \\ \underline{\underline{{\cdot}898}} \end{array} \begin{array}{l} \text{(By first method.)} \\ \\ \text{true to 3 places.} \end{array}$$

Exercise 72.

Write down the decimals of a pound sterling equivalent to the following amounts correct to three places by the first method, and prove by reducing according to the second method:—

	s.	d.		s.	d.		s.	d.
(1.)	1	3½	(8.)	8	9¼	(15.)	15	6
(2.)	2	4¾	(9.)	9	9	(16.)	16	7½
(3.)	3	5½	(10.)	10	2¾	(17.)	17	4
(4.)	4	11¾	(11.)	11	11¾	(18.)	18	9¾
(5.)	5	10½	(12.)	12	8½	(19.)	19	2
(6.)	6	8¾	(13.)	13	7¾	(20.)	19	11¾
(7.)	7	10	(14.)	14	8¼			

RULE LXXIII.

To write down *at once* in shillings, &c., the value of an decimal of a pound sterling.

1°. For shillings put $\frac{1}{5}$ of the first 2 decimal figures.

2°. If there be no excess, call the third decimal figure fa things. If there be an excess, consider the number formed b it and the third decimal figure as farthings. (For accurac each sixpence from the farthings must be called 5¾*d.*)

(This rule gives the value to *the nearest* farthing.)

Illustrative Example.—Write down at once in shillings, &c the value of £·8793.

The work is so simple that no figure working is required We merely divide 87 by 5, put the answer down as 17 shillings, then considering the 29 as 28 farthings and reducing to pence we have 7*d.*

·8793
£0, 17*s.* 7*d.* Ans

(By the ordinary rule the process is as here exhibited.)

$$\begin{array}{r} \cdot 8793 \\ 20 \\ \hline 17\cdot 5860 \\ 12 \\ \hline 7\cdot 0320 \\ 4 \\ \hline 0\cdot 1280 \end{array}$$

∴ the answer is £0, 17*s.* 7¾·128*d.*

Exercise 73.

Write down from sight the values in shillings, pence, an *farthings, of* the following decimals of a pound sterling, an afterwards prove your result by the ordinary process of reduction, giving the nearest farthing in each case:—

(1.) £·01145.
(2.) £·080208.
(3.) £·09895.
(4.) £·14166.
(5.) £·17083.
(6.) £·192708.
(7.) £·21666.
(8.) £·27395.
(9.) £·292708.
(10.) £·30729.
(11.) £·33958.
(12.) £·38125.
(13.) £0·40729.
(14.) £0·43437.
(15.) £0·47187.
(16.) £0·49062.
(17.) £0·54166.
(18.) £0·59895.
(19.) £0·61041.
(20.) £0·6375.
(21.) £0·65146.
(22.) £0·67916.
(23.) £0·72291.
(24.) £0·79687.
(25.) £0·80416.
(26.) £0·83958.
(27.) £0·88333.
(28.) £0·91562.
(29.) £0·93958.
(30.) £0·98854.

MISCELLANEOUS QUESTIONS IN DECIMALS.

These questions are taken from University Examination Papers.

Reduce:—

(1.) 5*s.* 6*d.* to decimal of £4.
(2.) $4\frac{1}{2}$ oz. „ „ 4 lbs. 1 oz. 4 drs.
(3.) ·6875 of 3*s.* 4*d.*
(4.) 5 fur. 97 yds. 2 ft. 3 in. to decimal of 1 mile.
(5.) $\frac{8}{1\cdot25}$ of a penny to the decimal of £1.
(6.) 8*s.* 4*d.* to the decimal of £1.
(7.) 7 oz. to decimal of 2 cwts.
(8.) ·8125 of 1 cwt. to qrs. lbs. &c.
(9.) $\frac{1}{8}$ of 2*s.* $7\frac{1}{2}$*d.* to decimal of 1 guinea.
(10.) £4, 17*s.* $3\frac{1}{2}$*d.* to decimal of 1 guinea.
(11.) 14·1275 acres to roods, &c.
(12.) £1, 14*s.* $9\frac{3}{4}$*d.* to decimal of 2 guineas.
(13.) ·72645 of £1, 14*s.* 6*d.*
(14.) $2\cdot\dot{3}\dot{5}$ miles to furlongs, &c.
(15.) 2*s.* $2\frac{1}{2}$*d.* to decimal of 1*s.* 8*d.*
(16.) 3 pks. 1 gall. 2 qts. 1 pt. to decimal of 8 bush.
(17.) 2 ft. 3 in. to the decimal of $4\frac{1}{2}$ yds.
(18.) £7, 13*s.* $6\frac{3}{4}$*d.* to decimal of £20.

Reduce:—

(19.) $2\frac{5}{16}$ of £1, 17*s.* 4*d.* to decimal of £5.

(20.) 2 ft. $7\frac{1}{2}$ in. to the decimal of 100 yards.

(21.) $\frac{2}{9}$ of 4 oz. 19 dwts. to the decimal of $2\frac{2}{3}$ of 16 dwts. 21 grs.

(22.) $\frac{3}{4}$ of £5, 19*s.* 0*d.* to decimal of £3, 12*s.* 11*d.*

(23.) 1 ton 3 cwts. 14 lbs. to decimal of 5 tons.

(24.) ·0375 of £1 + $5\cdot\dot{0}\dot{9}$ of 2*s.* 9*d.*

(25.) $2\frac{1}{2}$ gills to the decimal of $3\frac{1}{3}$ gallons.

(26.) $1\frac{1}{2}$ feet to the decimal of $\frac{1}{4}$ mile.

(27.) 2·5 of 1 ton 6 cwts. + 3·125 of 2 qrs. 16 lbs. + 3·75 of 448 oz.

(28.) £·9375 to shillings, &c.; 17*s.* 6*d.* to decimal of £1.

(29.) ·856 of 2 cwts. 26 lbs. ~ $3\cdot2\dot{2}\dot{7}$ of 2 qrs. 10 lbs.

(30.) Prove that ·3 of £1 + ·4 of 3*s.* $7\frac{3}{4}$*d.* + ·5 of 1*d.* = $\cdot\dot{6}$ of 11*s.* 3*d.*

(31.) Express $\dfrac{2\cdot8 \times 11\cdot\dot{3}\dot{6}}{5\cdot\dot{6}\dot{8}1}$ as a Vulgar Fraction.

(32.) Reduce ·375; ·0375 and $\cdot01\dot{0}\dot{9}$ to Vulgar Fractions.

(33.) Simplify (·064 + 12·25) ÷ ·9375.

(34.) Reduce 22·4 ÷ ·25 + 250 ÷ ·8 + 1·2 ÷ ·0075.

(35.) 2·34 × 1·025 ÷ ·0009.

(36.) Reduce $\cdot3\dot{6}\dot{3}$ of £2, 1*s.* 3*d.* to decimal of $\cdot\dot{7}\dot{2}$ of £3, 6*s.* 0*d.*

(37.) £$\cdot0\dot{2}\dot{1}$ ÷ ($1\cdot\dot{7}\dot{6}$*s.* − 3·2*d.*).

(38.) Compare the values of $\cdot7\dot{7}93650\dot{0}$ of a guinea; $\cdot\dot{8}\dot{1}$ of £1, and ·9816 of 16*s.* 8*d.*

(39.) Reduce $\cdot0208\dot{3}$ of £67, 4*s.* 0*d.* to decimal of 1 guinea.

(40.) Reduce (·0015 of 10*s.* + 2·0615 of 10*s.* 6*d.* + 1·04 of 2*s.* 6*d.*) to decimal of £1.

(41.) Find value of £4·790625, and reduce 8 yds. 9 in. to decimal of 1 mile.

(42.) Reduce 5 cwts. 1 qr. 13 lbs. 9 oz. to decimal of 1 ton.

(43.) Reduce 6*s.* 4*d.* to the decimal of £3, 6*s.* 8*d.*

(44.) How often is ·125 of £1 contained in 17·5 of 1*s.*?

(45.) (·775 of £5) ÷ (·01024 of 1*s.* $11\frac{1}{4}$*d.*).

COMMERCIAL ARITHMETIC.

PRACTICE.

Practice is the method of computing the value of any number of articles at a given or specified price per article by means of aliquot parts. It is based on the principle that the value of any number of articles at a fixed price is equal to the sum of the prices of the same number of articles at various amounts, which amounts in the gross equal the original specified price. Thus the price of 100 articles at 5*s*. 9*d*. is equal to the price of 100 @ 5*s*. + price of 100 @ 6*d*. + price of 100 @ 3*d*. There are many devices and short methods adopted in mercantile life for the calculation of prices, and several of them will be given in the article "Mental Arithmetic" at the end of this Treatise; but some modifications of great value will be presented in the Illustrative Examples which follow the Rules. Practice is Simple or Compound.

SIMPLE PRACTICE.

Rule LXXIV.

To find the price of any number of articles at a specified price each.

1°. Multiply the number of articles by the highest denomination in the price, and take aliquot parts for any and all lower denominations.

2°. Sum the results for the required price or value.

Note.—It is often more convenient to take a higher price than the one given, aliquot parts for the difference, and incrementally add the results; or to multiply the number of articles (or the price) by a certain number (2, 3, 4, or other) and divide the price (or the number of articles) by the same number. Other devices of a useful character will be exemplified in the

Illustrative Examples. The ingenious student will d
in the rule of Practice a very wide field in which to e
his powers, and much additional interest may be impa
the work of a class by stimulating it to discover and det
the most advantageous method of solution in each exa

Illustrative Examples.—(1.) Find by Practice the v
3210 articles @ £1, 18*s.* 6¾*d.* each.

We state the question as 3210 @ £2 ~ (1*s.* 5¼*d.*).

s.	*d.*						£	*s.*	*d.*	
1	4	$\frac{1}{15}$	3210							
			6420			= price @	2	0	0	
0	1	$\frac{1}{16}$	214			= „ „	0	1	4	]
0	0¼	$\frac{1}{4}$	13	7	6	= „ „	0	0	1	Incre
			3	6	10½	= „ „	0	0	0¼	Add
			£6189	5	7½	= „ „	1	18	6¾	

(2.) Find by Practice the value of 8457 articles @ £5, 1
each.

Again we state incrementally, and introduce an ad
element in the subsequent working; the question is
£6 ~ (6*s.* 9½*d.*).

s.	*d.*						£	*s.*	*d.*	
			8457							
6	0	$\frac{1}{20}$	50742			= price @	6	0	0	
0	9	$\frac{1}{8}$	2537	2	0	= „ „	0	6	0	]
0	0½	$\frac{1}{18}$	317	2	9	= „ „	0	0	9	Incre
			17	12	4½	= „ „	0	0	0½	Add
			£47870	2	10½	= „ „	5	13	2½	

(3.) Find by Practice the value of 9876 articles @ £6, 1
each.

If the incremental method be not used the followi
be adopted:—

s.	*d.*					
			9876			
15	0	$\frac{1}{8}$	59256			
0	9	$\frac{1}{20}$	7407			
0	0¾	$\frac{1}{12}$	370	7	0	
			30	17	3	
			£67064	4	3	Ans.

(4.) Find by Practice the value of 8157 articles @ £4, 19*s.* 10½*d.* each.

s.	*d.*					
1	0	$\frac{1}{20}$	8157			@ £5 ~ (1½*d.*).
			40785			
0	1½	$\frac{1}{8}$	~~407~~	~~17~~	~~0~~	price @ 1*s.* not needed.
			50	19	7½	
			£40734	0	4½	Ans.

(5.) Find by Practice the value of 5784¼ articles @ £7, 7*s.* 8¾*d.*

s.	*d.*						
			5784	5			
7	0	$\frac{1}{20}$	40489	15			
0	7	$\frac{1}{12}$	2024	9	9		
0	1¾	$\frac{1}{4}$	168	14	1¾		
			42	3	6¼	¾	
			£42725	2	5	¾	Ans.

(6.) Find by Practice the value of 362⅐ articles @ £7, 16*s.* 2¼*d.* each.

Here we multiply the number by 7 and divide the price by 7, so obtaining—

s.	*d.*					
2	0	$\frac{1}{10}$	2535 articles @ £1, 2*s.* 3¾*d.* each.			
			253	10	0	
0	3	$\frac{1}{8}$	31	13	9	
	¾	$\frac{1}{4}$	7	18	5¼	
			£2828	2	2¼	Ans.

Exercise 74.

(1.) 12345	@ 10*s.*; 6*s.* 8*d.*; 5*s.*; 4*s.*; 3*s.* 4*d.* each.
(2.) 67891	
(3.) 23456	
(4.) 78912	
(5.) 34567	
(6.) 89123	@ 2*s.* 6*d.*; 2*s.*; 1*s.* 8*d.*; 1*s.* 4*d.*; 1*s.* 3*d.*; 1*s.* each.
(7.) 45678	
(8.) 91234	
(9.) 56789	
(10.) 98765	

(11.) 43219
(12.) 87654
(13.) 32198 } @ 6*d.*; 4*d.*; 3*d.*; 2*d.*; 1½*d.*; 1*d.*; ½*d.*; ¼*d.* each.
(14.) 76543
(15.) 21987
(16.) 65432
(17.) 19876
(18.) 54321 } @ 16*s.* 8*d.*; 15*s.*; 14*s.*; 13*s.* 4*d.*; 12*s.* 6*d.* each.
(19.) 99887
(20.) 76655
(21.) 44332
(22.) 21199 } @ 12*s.*; 11*s.* 8*d.*; 11*s.* 4*d.*; 11*s.* 3*d.*; 11*s.*; 10*s.* 10*d.* each.
(23.) 88776
(24.) 65544
(25.) 33221 } @ 9*s.*; 8*s.* 4*d.*; 7*s.* 6*d.*; 7*s.*; 6*s.* 4*d.*; 6*s.* 3*d.* each.
(26.) 19988
(27.) 77665 } @ 6*s.*; 5*s.* 5*d.*; 5*s.* 4*d.*; 5*s.* 3*d.*; 5*s.* 2*d.* each.
(28.) 54433
(29.) 22119 } @ 19*s.*; 17*s.* 4*d.*; 16*s.* 6*d.*; 15*s.* 10*d.*; 18*s.* 8*d.* each.
(30.) 98877
(31.) 66554 } @ 9*s.* 10*d.*; 9*s.* 4*d.*; 8*s.* 4*d.*; 7*s.* 10*d.*; 7*s.* 9*d.* each.
(32.) 43322
(33.) 11998 } @ 12*s.* 10½*d.*; 11*s.* 10½*d.*; 7*s.* 6½*d.*; 8*s.* 6½*d.*; 9*s.* 3½*d.*
(34.) 87766 each.
(35.) 55443 } @ £1, 9*s.* 10*d.*; £1, 9*s.* 4*d.*; £1, 8*s.* 4*d.*; £1, 16*s.* 8*d.*;
(36.) 32211 £1, 17*s.* 4*d.* each.

			£	*s.*	*d.*					£	*s.*	*d.*	
(37.)	339	@	0	19	9¾	each.	(54.)	673	@	3	11	8¼	each.
(38.)	358	„	0	17	2½	„	(55.)	862	„	3	16	5¾	„
(39.)	967	„	0	13	6½	„	(56.)	991	„	7	15	8½	„
(40.)	702	„	0	19	7¼	„	(57.)	2963	„	1	16	9½	„
(41.)	917	„	1	0	6¼	„	(58.)	1594	„	2	13	10½	„
(42.)	776	„	10	11	9½	„	(59.)	4444	„	1	15	11¼	„
(43.)	862	„	6	13	7¾	„	(60.)	3786	„	1	14	10½	„
(44.)	954	„	7	15	8½	„	(61.)	9218	„	2	12	6¼	„
(45.)	376	„	9	2	6½	„	(62.)	5007	„	3	13	5¼	„
(46.)	914	„	15	17	8¾	„	(63.)	3037	„	7	17	6¾	„
(47.)	582	„	7	19	6½	„	(64.)	19615	„	4	11	11¾	„
(48.)	497	„	8	13	9¼	„	(65.)	72968	„	4	10	9½	„
(49.)	365	„	1	17	5½	„	(66.)	38672	„	3	11	1¼	„
(50.)	799	„	2	19	3¾	„	(67.)	232	„	15	12	8½	„
(51.)	815	„	2	18	0½	„	(68.)	258	„	5	19	0½	„
(52.)	474	„	2	9	5¼	„	(69.)	614	„	3	13	1	„
(53.)	509	„	2	10	7	„	(70.)	790	„	3	11	4	„

			£	s.	d.	
(71.)	1344	@	5	9	7	each.
(72.)	636	„	3	11	2¾	„
(73.)	446	„	2	6	4¼	„
(74.)	305	„	5	19	11¾	„
(75.)	1974	„	2	8	11¼	„
(76.)	989	„	9	15	8¾	„
(77.)	1772	„	15	11	6¾	„
(78.)	414	„	7	9	9	„
(79.)	638	„	19	13	5½	„
(80.)	348	„	3	10	11¾	„
(81.)	1164	„	3	19	9¼	„
(82.)	1491	„	8	13	9¼	„
(83.)	1869	„	14	16	3¼	„
(84.)	1931	@	37	16	1¼	each.
(85.)	1251⅓	„	38	14	2½	„
(86.)	2309⅓	„	98	9	2¼	„
(87.)	492	„	97	3	3¼	„
(88.)	1001$\frac{6}{7}$	„	98	5	7½	„
(89.)	1135$\frac{3}{5}$	„	86	8	5	„
(90.)	3923	„	4	11	11¾	„
(91.)	12161⅓	„	4	10	9½	„
(92.)	4296$\frac{8}{9}$	„	3	11	1¼	„
(93.)	40769	„	28	18	11	„
(94.)	7457$\frac{10}{11}$	„	76	8	7	„
(95.)	15304	„	869	1	8	„
(96.)	33329	„	7215	19	11¾	„

COMPOUND PRACTICE.

In Compound Practice both the quantity and the price are compound, *i.e.* composed of several denominations. There are several ways of solving the questions under this rule, some of which are subjoined. However, in actual business the "ready reckoner" is generally at hand, when a reference to its pages will often save a deal of valuable time.

Rule LXXV.

To find the value of a given quantity at a specified price when the quantity is composed of several denominations.

1°. Work upon the price, multiplying it by the denomination to which it belongs, and take aliquot parts for the lower denominations.

Illustrative Example.—Find the value by Practice of 10 cwts. 3 qrs. 21 lbs. @ £84 per cwt.

2	½	£84	0	0	= price of	1 cwt.
		840	0	0	= „	10 „
	½	42	0	0	= „	2 qrs.
14	½	21	0	0	= „	1 „
7	½	10	10	0	= „	14 lbs.
		5	5	0	= „	7 „
		£918	15	0	= „	10 cwts. 3 qrs. 21 lbs.

The same question can be worked by two other methods, which shall now be exhibited.

7	$\frac{1}{16}$	£84	0	0	=	price of 1 cwt.
		924	0	0	=	„ 11 „
		5	5	0	=	„ 7 lbs.
		£918	15	0	=	„ 10 cwts. 3 qrs. 21 lbs.

cwts.	qrs.	lbs.	
10	3	21	
	5	$2\frac{1}{7}$	
£10	18	9	= price of 10 cwts. 3 qrs. 21 lbs. @ £1 per cwt.
		12	
131	5	0	
		7	
£918	15	0	= price of 10 cwts. 3 qrs. 21 lbs. @ £84 per cwt.

Exercise 75.

Find the price of—

(1.) 104 ac. 3 ro. 10 po. @ £42, 15*s.* an acre.
(2.) 44 ac. 2 ro. 25 po. @ £55, 16*s.* 7½*d.* an acre.
(3.) 2 ac. 3 ro. 16 po. @ £24, 13*s.* 4½*d.* per rood.
(4.) 24 cwts. 3 qrs. 16 lbs. 10 oz. @ £2, 0*s.* 8*d.* per cwt.
(5.) 3 cwts. 2 qrs. 21 lbs. @ £55, 10*s.* 6*d.* per cwt.
(6.) 1 ton 14 cwts. 1 qr. 11 lbs. 12 oz. @ £4, 13*s.* 4*d.* per cwt.
(7.) 23 cwts. 1 qr. 23 lbs. @ £3, 18*s.* 9*d.* per cwt.
(8.) 39 ac. 2 ro. 18 po. @ £12, 5*s.* per acre.
(9.) $\cdot\dot{8}6$ lb. + $2\cdot3\dot{2}$ dwts. + $2\frac{4}{15}$ grs. @ £4, 4*s.* 11*d.* per ounce.
(10.) 2 tons 5 cwts. 2 qrs. 16 lbs. @ £113, 3*s.* 4*d.* per ton.
(11.) 23 tons 6 cwts. 2 qrs. 14 lbs. @ £3, 13*s.* 4*d.* per ton.
(12.) 17 ac. 2 ro. 25 po. @ £76, 10*s.* per acre.
(13.) 2 cwts. 3 qrs. 7 lbs. @ £4, 15*s.* 8*d.* per cwt.
(14.) 8 oz. 12 dwts. 18 grs. of gold @ £3, 18*s.* 4*d.* per ounce.
(15.) Value of 3 pockets of hops, each 1 cwt. 3 qrs. 14 lbs. @ £3, 12*s.* 6*d.* per cwt.
(16.) 20 ac. 3 ro. 15 po. @ £675 per acre.
(17.) 220 miles 3 fur. 20 po. 5 yds. @ £11 per mile.
(18.) 7 oz. 13 dwts. 15 grs. @ £3, 10*s.* per ounce.
(19.) 2 wks. 4 dys. 10 hrs. @ 36*s.* per week (1 week = 6 days; 1 day = 12 hours).
(20.) 2 qrs. 1 bush. 1 peck @ 4*s.* 4*d.* per bushel.
(21.) 3 silver candlesticks, each 4 oz. 7 dwts. @ 7*s.* 6*d.* per ounce.
(22.) 2 qrs. 3 bush. 1 peck @ £5, 16*s.* per quarter.

Find the price of—

(23.) 3 pecks 1 gal. 3 qts. 1 pt. @ £4, 12*s.* per gallon.
(24.) 2 qrs. 14 lbs. @ £5, 16*s.* 8*d.* per ton.
(25.) 2 tons 21 lbs. @ £12, 10*s.* per cwt.
(26.) 3 lbs. 5 oz. 14 dwts. 12 grs. @ 17*s.* 6*d.* per ounce.
(27.) 26 ac. 3 ro. 25 po. @ £2, 13*s.* 4*d.* per acre.
(28.) 34 cub. yds. 3 ft. 288 in. @ £3, 6*s.* 9*d.* per yard.
(29.) 87 yds. 1 ft. 10 in. @ £3, 6*s.* 8*d.* per chain.
(30.) 5 ac. 2 ro. 11 po. @ £95 per acre.
(31.) 5 ac. 3 ro. 7 po. 88 yds. @ £161, 6*s.* 8*d.* per acre.
(32.) 2 ro. 19 po. 19 sq. yds. @ £40, 6*s.* 8*d.* per acre.
(33.) 12 silver bars, each 5 lbs. 7 oz. 19 dwts. 22 grs. @ 4*s.* 7*d.* per ounce.
(34.) 14 ac. 3 ro. 26⅔ po. @ £52, 7*s.* 6*d.* per acre.
(35.) What is the total produce of a field of 18 ac. 1 ro. 28¾ po. @ 7 qrs. 6 bush. 2 pks. per acre?

VARIATION.

Ratio and Proportion can only be fully taught in works on Algebra and Geometry. The usual result with pupils in the "Proportion" rule, as given in the ordinary books on arithmetic, is uncertainty, confusion, and inaccuracy, the learners acquiring very vague ideas indeed on the theory and principles of the subject. The "Fractional Form" which is here introduced is intended to supersede the so-called "statings," and with a little supplementary explanation from the teacher it can be made intelligible to the dullest scholar. The practical utility of the method is self-evident.

Rule LXXVI.

To solve questions and problems in which quantities vary directly or indirectly the one with the other; two quantities being said to vary *directly*, when they are so related that they increase or decrease simultaneously; and to vary *indirectly*, when as one increases the other decreases.

1°. Place the given fact or facts in a line, putting the sign of equality before the figures indicating the known price, work done, &c.

2°. Under the statement write the question term for term, using for the vacant space where the required answer should come the sign ?.

3°. Draw a horizontal line for the required fractional form, above which place the odd term, writing the denomination at the end of the line.

4°. Now consider any one pair of like terms and ask, Do this denomination and the odd term vary directly or indirectly? If directly, invert the position of the figures composing the term under consideration in the fractional form; if indirectly, place the figures unchanged in position in the fractional form.

5°. Proceed in like manner with all the terms until none remain, putting the sign of multiplication between each item of both numerator and denominator, then cancel out, multiply out, and reduce.

It will be observed that there is no distinction made here between simple and complex problems. The folly of creating an imaginary difference where none really exists, as is done by speaking of "Simple and Compound" Proportion, and thus conducing to bewilderment on the part of the pupil, is only recognized to be condemned.

Illustrative Examples.

1. If 16 tons cost £56, what will 50 tons cost at the same rate?

$$\left.\begin{array}{l}\text{By 1°.}\ \ 16 \text{ tons} = \pounds 56 \\ \ \ ,,\ \text{2°.}\ \ 50\ \ ,,\ \ = \ ?\end{array}\right\}\ \text{By 3° and 4°}\ \pounds\frac{\overset{7}{\cancel{56}} \times \overset{25}{\cancel{50}}}{\cancel{16}} = \underline{\underline{\pounds 175.}}\ \ \text{Ans.}$$

By 4° we ask, Do *tons* and *price* vary directly or indirectly? Of course always directly, *i.e. as* the number of tons increase *so* must the total price. We therefore write 50 above and 16 below. The proof of this arrangement is as follows. If £56 be the cost of 16 tons we get the price of 1 ton by dividing £56 by 16; and if $\pounds\frac{56}{16}$ be the price of 1 ton, 50 times that price, or $\pounds\frac{56 \times 50}{16}$, must be the price of 50 tons.

By 5° we cancel out, multiply, and reduce.

2. If 10 men mow a field in 12 days, in how many days will 15 men mow it?

$$\left.\begin{array}{l}10 \text{ m.} = \text{work in } 12 \text{ days.} \\ 15\ ,,\ =\ \ \ \ ,,\ \ \ \ ?\ \ ,,\end{array}\right\}\ \frac{\overset{4}{\cancel{12}} \times \overset{2}{\cancel{10}}}{\cancel{15}}\ \text{days} = \underline{\underline{8 \text{ days.}}}\ \ \text{Ans.}$$

Men and days vary indirectly, for the more men the less days will the work take. We therefore leave 10 and 15 unchanged *in position*; then cancel and multiply, &c., as before.

3. If 250 men construct a bank 300 yds. long, 15 yds. wide, and 10 yds. high, in 12 days of 10 hrs. each, what must be the length of a bank 30 yds. wide and 20 yds. high, which 600 men construct in 40 days of 8 hrs. each?

	(1)	(2)	(3)	(4)	(5)
	yds.	yds.	yds.		
250 m. =	300 long,	15 wide, and	10 high in	12 days of	10 hrs. each.
600 „ =	? „	30 „	20 „	40 „	8 „

$$\frac{\overset{15}{\cancel{300}} \times \cancel{600} \times \cancel{15} \times \cancel{10} \times 4\cancel{0} \times 8}{\cancel{250} \times \cancel{30} \times \cancel{20} \times \cancel{12} \times \cancel{10}} \text{ yards} = 4 \times 8 \times 15 = \underline{\underline{480 \text{ yds.}}} \text{ Ans.}$$

The required length of bank must vary—

(1) directly as number of men employed.
(2) indirectly „ „ yards in width.
(3) „ „ „ „ height.
(4) directly „ „ days (or time).
(5) „ „ „ hours („).

In order to illustrate the superiority of this mode of solving complex problems in arithmetic, an extremely tedious question, extracted from a well-known treatise, will be given and worked out in full.

4. If $\frac{3\frac{1}{3} \text{ of } 11\frac{1}{2}}{13\frac{1}{2}}$ of £$2\frac{8}{23}$ will purchase $\frac{3}{8}$ of $\frac{2}{9}$ of 192 yards of steel rails weighing 70 lbs. per yard, what should be the weight per yard of 2 fur. 120 yds. of the same quality of rails which cost £$\dfrac{\frac{11\frac{1}{3}}{7} \div \frac{\frac{1}{3}}{\frac{1}{17}}}{\frac{1}{840}}$?

$$\left.\begin{array}{l} \dfrac{3\frac{1}{3} \text{ of } 11\frac{1}{2}}{13\frac{1}{2}} \text{ of } £2\frac{8}{23} \overset{\text{(purchases)}}{=} \frac{3}{8} \text{ of } \frac{2}{9} \text{ of 192 yds. @ 70 lbs. per yd.} \\ £\dfrac{\frac{11\frac{1}{3}}{7} \div \frac{\frac{1}{3}}{\frac{1}{17}}}{\frac{1}{840}} \qquad = \text{2 fur. 120 yds.} \quad \text{@ ? „ „} \end{array}\right\}$$

All these complex fractional forms will be written in place without any difficulty whatever, and without the slightest reference to their complexity or simplicity.

$$\frac{70 \times \dfrac{\dfrac{11\frac{1}{3}}{7} \div \dfrac{\frac{1}{3}}{\frac{1}{17}}}{\frac{1}{840}} \times \frac{3}{8} \times \frac{2}{9} \times 192}{\dfrac{3\frac{1}{3} \text{ of } 11\frac{1}{2}}{13\frac{1}{2}} \times 2\frac{8}{23} \times 560} \text{ lbs.}$$

$$= \frac{\cancel{70} \times \overset{3}{\cancel{840}} \times \cancel{34} \times \cancel{3} \times \cancel{3} \times \cancel{2} \times \overset{24}{\cancel{192}} \times \cancel{3} \times \cancel{2} \times \cancel{27} \times \cancel{23}}{\cancel{3} \times \cancel{7} \times \cancel{17} \times \cancel{8} \times \cancel{9} \times \cancel{10} \times \cancel{23} \times \cancel{2} \times \cancel{54} \times \cancel{560}} \text{ lbs.}$$

$= (3 \times 24)$ lbs. $=$ 72 lbs. Ans.

Exercise 76.

(1.) How many hours a day must 171 men work to do in 91 days what it takes 143 men 133 days of 9 hrs. each to do?

(2.) If 8 men build 2 roods of wall one brick thick in 3 days how many men can build 5 roods of wall one and a half bricks thick in a week?

(3.) If 1 cwt. 2 qrs. 14 lbs. of sugar cost £3, 0*s.* 8*d.*, what will 7 lbs. cost?

(4.) If 7 francs are worth 5*s.* 8¼*d.*, what will 20570 francs represent?

(5.) If 10 horses eat 7 bush. 2 pks. in 7 days, how many horses will eat 3 qrs. 6 bush. at the same rate in 10 days?

(6.) If 1000 sovereigns weigh 21 lbs. 5 oz. 16 dwts., what will 192 sovereigns weigh?

(7.) If £20 gain £16 in 5 months, what sum will gain £24 in 3 months?

(8.) If $2\frac{3}{4} \sim 1\frac{5}{8}$ of an estate cost £440, what will $2\frac{1}{2}$ of $6\frac{5}{12}$ cost?

(9.) If 152 sacks contain 65 qrs. 2 bush. 2 pks., how many sacks will contain 18 qrs. 7 bush. 1 pk.?

(10.) A man walks 600 miles in 25 days walking 8 hrs. daily, in how many days of 10 hrs. will he walk 330 miles?

(11.) If it costs 16 guineas to supply 30 men 48 women and 60 boys with bread for a week, supposing a man to eat twice as much as a boy and a woman one fourth less than a man, how much will it cost to supply 25 men 60 women and 72 boys with bread for 10 days?

(12.) If the income tax on £300 be £11, 5*s.* 0*d.*, what should £525, 10*s.* 0*d.* pay as a tax?

(13.) If 4 men earn £3, 10*s*. 0*d*. in 6½ days, what will 17 men earn in 4 weeks of 5⅓ days each?

(14.) If 2 ro. 15 poles cost £59, 7*s*. 6*d*., what will 8 ac. 17 poles be worth?

(15.) If 10 men and 15 boys reap a field in 6 days, in what time will 7 men and 12 boys do it (given that 2 men can do the work of 3 boys)?

(16.) If 8 horses plough 11⅔ acres in 2 days, in what time will 6 horses plough 17½ ac.?

(17.) If 17 yds. cost £4, 8*s*. 6½*d*., what will 120 yds. cost?

(18.) If 25 chests weigh 1 ton 3 cwts. 1 qr. 21 lbs., how many will weigh 1 ton 11 cwts. 3 qrs. 14 lbs.?

(19.) If 10 horses eat 7 bush. 2 pks. of corn in 7 days, how many will eat 3 qrs. 6 bush. in 10 days?

(20.) If 44 labourers do a work in 15 days of 10 hrs., how many navvies will do ¾ more work in 7 days of 11 hrs., if 3 navvies do the work of 5 labourers?

(21.) In what time will 12 men do a work which 8 men can do in 27 days?

(22.) A. goes 78 miles in 13 hours, in what time will he go 60 miles?

(23.) Three men mow 15 ac. in 6⅔ days, how long will 10 men take to do it?

(24.) Five horses eat 8 bush. 1¾ pks. in 9 days, how long will 66 bush. 3¾ pks. last 17 horses?

(25.) Fifteen yards cost £1, 13*s*. 9*d*., what will 20 yds. 1 ft. cost at same rate?

(26.) A. earns thirty shillings in 8 days of 9 hrs. each, in how many days of 10 hrs. each can he earn 50/?

(27.) 288 yds. cost £4, 14*s*. 10½*d*., what number of yards will cost £1, 11*s*. 7½*d*.?

(28.) Seventy men dig 1 ac. 2 ro. 10 po. in 5 days, how many can dig 2¼ ac. in 28 days?

(29.) Three persons spend £7 in 4 weeks, how many will spend £112 in 13 weeks 5 days?

(30.) Seventeen men earn £6, 7*s*. 6*d*. in 2 days, how many will earn £11, 5*s*. 0*d*. in 4 days?

(31.) Twenty-five men do a work in 4 days of 6 hrs. each, how many hours per day for 5 days must 24 men work to do the same task?

(32.) If 8 men do a work in 75 days, how many men would do it in 40 days?

(33.) Twenty-five horses cost £11, 6*s*. 0½*d*. in corn, &c., week, how much will 13 horses cost from Septembe to October 31?

(34.) How many men will do in 19 days a work which 1 men do in 12 days?

(35.) Twelve persons require £11, 16*s*. 3*d*. worth of meat 5 weeks when meat is 9*d*. per lb., how much will persons require for 7 weeks when meat is 1/ per lb.?

(36.) Fifteen men earn £68, 12*s*. 6*d*. in 25 days, in what ti will 20 men earn £35?

(37.) How far will 48 tons be carried for the money whi carries 36 tons 144 miles?

(38.) If 6 men do a work in 30 days of 9 hrs. each, how ma men will do 10 times the work in 25 days of 8 hrs. ea

(39.) A book of 320 leaves, 21 lines on each page, and elev words to a line, costs £19, what will a book of 2 leaves cost, with 28 lines on a page, and 10 words i line?

(40.) Seven men live on £140 for 28 weeks, how long w £135 last 9 persons?

(41.) Four men earn £6 in 12 days, what would 6 men ea in 10 days?

(42.) If £3, 10*s*. 0*d*. be paid for 18 weeks' service, how lo will £8, 15*s*. 0*d*. pay for?

(43.) If 45 men do a work in 16 days of 10 hrs. each, in ho many days of 12 hrs. would 100 men do it?

(44.) If 29 men earn £80, 9*s*. 6*d*. in 54 days, how many wi earn £407 in 12 days?

(45.) If 159 articles cost 19*s*. 10½*d*., what will 161 articles cost

(46.) If 3 men do a work in 60 days, how many will do it i 20 days?

(47.) How many men will mow 114 ac. in 9 days, if 14 me mow 76 ac. in 6 days?

(48.) If 15 men build a wall 25 yds. long 2 yds. high and 2 f thick in 14 days, in what time will 7 men build a wa 30 yds. long 7 ft. high and 1 foot thick?

(49.) What will 60 men earn, if 36 men earn £28, 16*s*. 0*d*.?

(50.) The carriage of 4 tons is 17*s*. 4*d*., what will 6 tons 3 cwt 3 qrs. cost in carriage?

(51.) How much will 20 men earn in 4 days, if 14 men ea £9, 16*s*. in 7 days?

(52.) If 5 men mow 33 ac. in 5 days of 11 hrs. each, in wh time would 4 men reap 32 acres, working 10 hrs. dail if they reap 5 acres in the same time that they can mow 6?

(53.) If 3000 copies cost £4725, what will 1937 copies be worth?

(54.) What will 30 men and 50 boys earn in 32 days if 54 men earn £60, 15*s.* 0*d.*, supposing 2 men to do as much work as 5 boys?

(55.) If 9 ac. 1 ro. 32 po. of pasture suffice for 25 sheep, how much pasture will be required for 480 sheep?

(56.) If 12 furnaces consume 12 tons 9 cwts. 21 lbs. in 10 hrs., how long will 7 furnaces be in consuming 15 tons?

(57.) What is the rent of 34 ac. 1 ro. 10 po., if 6 ac. 3 ro. 18 po. be let for £21, 9*s.* 9*d.*?

(58.) How many miles can a man walk in an hour, if he walk 11 yds. in 5 seconds?

(59.) If 3 ac. 2 ro. 12 po. grow 15 qrs. 3 bush. 2 pks. of wheat, what will 7 ac. 3 ro. 36 po. yield?

(60.) How much corn can I purchase for £85, 8*s.* 4*d.* at the rate of 1 qr. 2 bush. 2 pks. for £3, 11*s.* 9*d.*?

(61.) If 5 men dig a trench in 1⅓ days of 4½ hrs. each, how long would one man take to dig a trench half as large again working 5 hrs. a day?

(62.) If 3 men working 4 hrs. daily can build a wall 80 ft. long 6 ft. high and 2 ft. thick in 5 days, how many men working 3½ hrs. a day can build a wall 100 ft. long 7 ft. high and 4 ft. thick in 25 days?

(63.) If 45 women earn £207 in 48 days, how many days must 25 men work to earn £76, 13*s.* 4*d.*, a man's wages being double those of a woman?

(64.) If 620 men dig a trench 5 ft. 6 in. broad, 4 ft. deep, and 155 yds. long in half an hour, what length of trench 10 ft. broad and 8 ft. deep can 2400 men dig in 6 hrs.?

(65.) If 16 pioneers in 5 days of 12½ hrs. long can dig a trench 139·75 yds. long 4½ yds. wide and 2½ yds. deep, how many hours per day must 90 pioneers work during 42 days in order to dig a trench $4910\frac{1}{16}$ yds. long $4\frac{7}{8}$ yds. wide and $3\frac{1}{5}$ yds. deep?

(66.) If 248 navvies in 5½ days of 11 hrs. each dig a trench 232½ ft. long 3 ft. 8 in. wide and 2 ft. 4 in. deep, in how many days of 9 hrs. each should 24 navvies dig a trench 337½ ft. long $5\frac{3}{5}$ ft. wide and 42 inches deep if the degree of hardness of the ground in the first case be to that in the second as 7 to 4?

SIMPLE INTEREST.

By the rule of "Simple Interest" we are enabled to calculate the amount of interest accruing on a given Principal fo any length of time at a fixed rate per cent. In Simple Interes the interest is supposed to be paid at the end of every yea by the borrower. Problems in this rule are solved by th principle of Variation. The following formulas, which must b committed to memory, will be all that is necessary to enabl the pupil to calculate correctly any ordinary questions tha may be proposed. Each formula should be fully explained b the teacher on the Unitary or Fractional Method.

Formula

$$(a)\quad I=\frac{P\times R\times T}{100}=\frac{P\times R\times T(\text{months})}{1200}=\frac{P\times 2R\times T(\text{days})}{73{,}000}$$

$$(b)\quad P=\frac{100\times I}{R\times T}.$$

$$(c)\quad R=\frac{100\times I}{P\times T}.$$

$$(d)\quad T=\frac{100\times I}{P\times R}.$$

$$(e)\quad P=\frac{100\times A}{100+(R\times T)}.$$

Where
P = Principal.
I = Interest.
T = Time in years.
R = Rate per cent.
A = Amount (or Principal increased by its Interest).

Rule LXXVII.

To find "Simple Interest" — Principal, Rate, and Time being given.

1°. Divide the product of Principal, Rate, and Time by 100.

Note.—In all the Rules in this subject P stands for Principal, I for Interest, T for Time (in years), R for Rate per cent, and A for Amount.

Illustrative Examples.

1. Find the Interest on £5674 for 5 years at 4°/ₒ.

$$\text{Formula }(a)\ I=\frac{P\times R\times T}{100}=\frac{5674\times\cancel{5}\times\cancel{4}}{\underset{5}{\cancel{100}}}=\underline{\underline{\pounds 1134,\ 16s.\ 0d.}}\ \text{Ans}$$

Should the time be in months the formula is modified as follows:—

2. Calculate the Interest on £1728 for 3 yrs. 5 mos. at $5^\circ/_\circ$.

3 yrs. 5 mos. = 41 mos.

$$I = \frac{\overset{144}{\cancel{1728}} \times 41 \times \cancel{5}}{\underset{20}{\cancel{1200}}} = \frac{5904}{20} = \underline{\underline{£295,\ 4s.\ 0d.}} \quad \text{Ans.}$$

If the time should include days the work will be as follows:—

3. Find the Simple Interest on £10000 for 2 yrs. 123 days at $3\frac{1}{5}{}^\circ/_\circ$.

$$I = \frac{10000 \times 3\frac{1}{5} \times 2\frac{123}{365}}{100} = \frac{10000 \times 16 \times 1706}{100 \times 5 \times 730} = \frac{54592000}{73000} =$$

$$\underline{\underline{£747,\ 16s.\ 8\tfrac{1}{2}d.}} + \quad \text{Ans.}$$

(See Rule LXXIX.)

Exercise 77.

		£	s.	d.			
(1.)	Find Simple Interest on	5982	7	6	for	4 yrs.	@ $3\frac{3}{4}{}^\circ/_\circ$.
(2.)	„ „ ,	850	0	0	„	$3\frac{1}{4}$ „	„ $4\frac{1}{2}$ „
(3.)	„ „ „	635	18	$4\frac{1}{2}$	„	$3\frac{1}{2}$ „	„ 3 „
(4.)	„ „ „	451	17	6	„	4 „	„ $2\frac{1}{4}$ „
(5.)	„ „ „	346	15	0	„	2 y. 220 ds.	„ 5 „
(6.)	„ „ „	112	10	0	„	3 yrs.	„ $3\frac{1}{3}$ „
(7.)	„ „ „	2294	18	9	„	2 y. 115 ds.	„ 5 „
(8.)	„ „ „	222	12	11	„	7000 ds.	„ 2*s.* pr wk.
(9.)	„ „ „	41	13	4	„	8 mos.	„ $4\frac{1}{2}{}^\circ/_\circ$.
(10.)	„ „ „	250	0	0	„	$2\frac{1}{2}$ yrs.	„ $3\frac{1}{2}$ „
(11.)	„ „ „	1585	17	6	„	$6\frac{2}{3}$ „	„ $4\frac{1}{2}$ „
(12.)	„ „ „	3050	10	6	„	$3\frac{1}{4}$ „	„ 5 „
(13.)	„ „ „	612	10	0	„	6 „	„ $3\frac{1}{2}$ „
(14.)	„ „ „	2000	0	0	„	3 „	„ $7\frac{1}{2}$ „
(15.)	„ „ „	376	10	8	„	$5\frac{1}{2}$ „	„ $3\frac{1}{2}$ „
(16.)	„ „ „	3220	0	0	„	$5\frac{3}{4}$ „	„ 7 „
(17.)	„ „ „	2270	0	0	„	$5\frac{1}{2}$ „	„ 6 „
(18.)	„ „ „	1001	15	9	„	7 „	„ $8\frac{3}{5}$ „
(19.)	„ „ „	840	15	0	„	3 „	„ $6\frac{3}{4}$ „

(20.)	Find Simple Interest on	7240	0	0	for 5½ yrs.	@
(21.)	„ „ „	3728	19	7½	„ 5 „	„
(22.)	„ „ „	275	10	0	„ 2y.146ds.	„
(23.)	„ „ „	507	10	0	„ 4 „	„
(24.)	„ „ „	1257	15	0	„ 4 „	„
(25.)	„ „ „	260	10	0	„ 4¼ „	„
(26.)	„ „ „	786	12	6	„ 3½ „	„
(27.)	„ „ „	900	0	0	„ 3 „	„
(28.)	„ „ „	954	6	8	„ 5 „	„
(29.)	„ „ „	977	3	4	„ 5 „	„
(30.)	„ „ „	6980	10	0	„ 3½ „	„

It will be expedient at this stage to give the short r division by 100 and also by 73000. So many quest Simple Interest involve the division by 100, and 36 multiples, that it is essential, in order to save time an to furnish a concise method of dividing by these n The rules are occasionally asked for in public exami and where they are not actually employed in the sol the questions they afford a simple and easy mode of the accuracy of the answers, a matter of no small imp in an examination.

Rule LXXVIII.

To divide any amount consisting of pounds, shillin pence by 100, writing the answer down at once.

1°. Mark off the two right-hand figures from the and call the remaining figures, to the left of these two pounds in the answer.

2°. For shillings divide the figures cut off by five quotient will give the shillings.

3°. Now prefix any remainder there may be to h *nearest* number of shillings: call the number so form things, reject one for every twenty-five in this numl reduce the residue up to pence.

Illustrative Example.—1. Divide £57893, 17*s.* 10¾*d.*

£578,93, 17*s.* 10¾*d.*

£578, 18*s.* 9¼*d.* Ans.

By 1°, 93 is cut off and 578 becomes pounds for answer. Then by 2°, $93 \div 5 = 18$ and 3 over, 18 becomes shillings in answer. By 3°, prefixing 3 to half the number of shillings we get 39, calling it 37 (for twenty-fifths), and the full answer is £578, 18*s.* 9¼*d.*

Exercise 78.

Divide each of the following amounts by 100, writing down the result at once to the nearest farthing. Then prove each answer by the ordinary method of division:—

	£	*s.*	*d.*		£	*s.*	*d.*
(1.)	123	4	5½	(11.)	40579	3	6½
(2.)	14567	8	9¾	(12.)	8	9	4¼
(3.)	87065	13	11¼	(13.)	36	17	8¾
(4.)	9988	17	6¾	(14.)	457	8	11¼
(5.)	80157	16	3½	(15.)	1521	0	6¾
(6.)	2468	10	11½	(16.)	72481	19	11¾
(7.)	101501	1	0¼	(17.)	188864	18	10½
(8.)	33333	13	3¾	(18.)	352148	17	9¾
(9.)	5555	15	5¼	(19.)	24405	16	11¾
(10.)	77717	7	7¾	(20.)	108070	11	7½

Rule LXXIX.

To divide any quantity by 73000.

1°. Add to the dividend one-third of itself, one-tenth of that third, and one-tenth of that tenth (rejecting all shillings and remainders).

2°. Cut off five figures to the right and reject one farthing for each £10 in the answer (1 farthing for every £10, 8*s.* 4¼*d.*).

3°. The figures to the left will be pounds integral, whilst the five figures cut off will be decimal, which reduce for shillings and pence.

Illustrative Example. — Divide £3674156, 3*s.* 11¾*d.* by 73000.

$$\begin{array}{r} 3674156 \\ 1224718 \\ 122471 \\ 12247 \\ \hline 50\,.\,33593 \\ \hline \end{array}$$

£50, 6*s.* 7½*d.* nearly. Ans.

Exercise 79.

Divide each of the following amounts by 73000 by the third, tenth and tenth rule, proving your answers by the ordinary method of division:—

(1.) £1234567
(2.) £2345678
(3.) £3456789
(4.) £4567892
(5.) £5678923
(6.) £6789345
(7.) £7894567
(8.) £8912345
(9.) £9876543
(10.) £2198765
(11.) £4321098
(12.) £7654321
(13.) £8765403
(14.) £6050403
(15.) £5544332
(16.) £3322119
(17.) £1122334
(18.) £7205614
(19.) £231541
(20.) £4789216
(21.) £5234789
(22.) £1982736
(23.) £5289627
(24.) £4668657
(25.) £99999999

Rule LXXX.

To find the Principal: Interest, Rate, and Time being given.

1°. Divide the Product of 100 and Interest by the product of the Rate and Time.

Formula (*b*) $P = \frac{100 \times I}{R \times T}$.

Illustrative Example.—What Principal will yield £128, 12*s.* 6*d.* as Interest in six years @ 3½ per cent?

$$P = \frac{100 \times £128,\ 12s.\ 6d.}{6 \times 3\frac{1}{2}} = £\frac{100 \times \overset{6 \cdot 125}{\cancel{128 \cdot 625}}}{\cancel{21}} = £612 \cdot 5 = \underset{\text{Ans.}}{\underline{\underline{£612,\ 10s.}}}$$

Exercise 80.

			£	s.	d.		Years.			
(1.)	What Principal	will yield	30	0	0	as Interest in	1	@	4	%?
(2.)	„	„	168	15	0	„	3	„	8	„
(3.)	„	„	516	11	7½	„	33⅓	„	3	„
(4.)	„	„	76	10	0	„	6	„	4	„
(5.)	„	„	1	4	8⅜	„	2½	„	½	„
(6.)	„	„	17	14	6	„	3	„	2½	„
(7.)	„	„	6	18	10	„	3½	„	1	„
(8.)	„	„	75	12	9⅗	„	4	„	2	„
(9.)	„	„	167	0	0	„	5	„	6	„
(10.)	„	„	74	18	6	„	4	„	2	„

RULE LXXXI.

To find the Rate: Principal, Interest, and Time being given.

1°. Divide the product of 100 and Interest by the product of the Time and Principal, or

$$\text{Formula } (c) \quad R = \frac{100 \times I}{P \times T}.$$

Illustrative Example.—At what rate per cent will £5600 amount to £7000 in 6 years?

$$R = \frac{\cancel{100} \times \overset{25}{\cancel{1400}}}{\cancel{5600} \times 6} = \frac{25}{6} = \underline{\underline{4\tfrac{1}{6} \text{ per cent.}}} \quad \text{Ans.}$$

Exercise 81.

		£	s.	d.		£	s.	d.	
(1.)	At what rate °/o will	500	0	0	amt. to	567	10	0	in 1½ years?
(2.)	„ „	127	9	4½	„	144	1	$3\frac{115}{128}$	„ 4⅙ „
(3.)	„ „	281	12	0	„	318	5	4	„ 4⅙ „
(4.)	„ „	371	13	7¼	„	743	7	2½	„ 30 „
(5.)	„ „	250	0	0	„	302	10	0	„ 2 „
(6.)	„ „	4420	0	0	„	6121	14	0	„ 5½ „
(7.)	„ „	625	0	0	„	730	9	4½	„ 3¾ „
(8.)	„ „	2100	0	0	„	5250	0	0	„ 3 „
(9.)	„ „	397	10	0	„	484	19	0	„ 4 „
(10.)	„ „	785	0	0	„	926	6	0	„ 4½ „

RULE LXXXII.

To find the Time when Principal, Interest, and Rate are given.

1°. Divide the product of 100 and Interest by the product of the Rate and the Principal, or

$$\text{Formula } (d) \quad T = \frac{100 \times I}{P \times R}.$$

Illustrative Example.—In what time will £2000 produce £280 @ 3½ per cent?

$$T = \frac{100 \times 280}{2000 \times 3\frac{1}{2}} \text{ yrs.} = \frac{\cancel{100} \times \overset{4}{\cancel{280}} \times \cancel{2}}{\cancel{2000} \times \cancel{7}} \text{ yrs.} = \underline{\underline{4 \text{ years.}}} \quad \text{Ans.}$$

Exercise 82.

		£	s.	d.		£	s.	d.			
(1.)	In what time will	275	0	0	produce	75	19	4½	as Int.	@	4¼ °/ₒ
(2.)	” ”	1250	0	0	”	371	17	6	”	”	4¼ ”
(3.)	” ”	1505	2	1½	”	662	4	$11\frac{11}{50}$	”	”	8 ”
(4.)	” ”	3465	0	0	”	1576	11	6	”	”	6½ ”
(5.)	” ”	756	0	0	”	75	12	0	”	”	4 ”
(6.)	” ”	3875	0	0	”	339	1	3	”	”	3½ ”
(7.)	” ”	362	10	0	”	47	2	0	”	”	3¼ ”
(8.)	” ”	342	10	0	”	57	19	0	”	”	3½ ”
(9.)	” ”	543	15	0	”	114	3	9	”	”	5¼ ”
(10.)	” ”	372	10	0	”	126	13	0	”	”	4 ”

RULE LXXXIII.

To find the Principal when Amount, Rate, and Time ar given.

1°. Divide the product of 100 and the amount by 100 increased by the product of the Time and Rate.

$$\text{Formula } (e) \quad P=\frac{100\times A}{100+(T\times R)}.$$

Illustrative Example.—What sum will amount to £237, 10 in 2 years @ 7 per cent?

$$P=£\frac{100\times 237\frac{1}{2}}{100+(2\times 7)}=£\frac{\overset{25}{\cancel{100}}\times\overset{25}{\cancel{475}}}{\cancel{2}\times\underset{3}{\cancel{114}}}=£\frac{625}{3}=\underline{\underline{£208,\ 6s.\ 8d.}}\quad \text{Ans.}$$

Exercise 83.

		£	s.	d.						
(1.)	What sum will amount to	1051	5	0	in	1	year	@	5⅛	°/ₒ?
(2.)	” ”	188	2	6	”	1½	”	”	5	”
(3.)	” ”	1680	0	0	”	4	”	”	4½	”
(4.)	” ”	44	3	0¼	”	2½	”	”	3¼	”
(5.)	” ”	323	6	10½	”	$7\frac{1}{7}$	”	”	3½	”
(6.)	” ”	124	13	4	”	7½	”	”	5	”
(7.)	” ”	555	0	0	”	3½	”	”	$3\frac{1}{7}$	”
(8.)	” ”	678	13	10	”	1¼	”	”	6	”
(9.)	” ”	435	8	$4\frac{4}{5}$	”	4	”	”	4½	”
(10.)	” ”	1009	3	4	”	2½	”	”	3¼	”

RULE LXXXIV.

To find how much per day will amount to a certain sum per year.

1°. Express the given sum in pounds and decimals of a pound.

2°. Take two-thirds of this amount and call it pence.

3°. Reject one farthing in every eighteen pence, or (which is the same thing) one penny in every six shillings, or tenpence for each three pounds in the answer, for the true daily sum.

Illustrative Examples. — 1. What daily amount will give £265, 17*s.* 6*d.* yearly?

By 1°. £265, 17*s.* 6*d.* = £265·875
$\quad$ 88·625 = $\frac{1}{3}$
$\quad$ 177·25 by 2°

but 177·25*d.* = 14*s.* $9\frac{1}{4}$*d.* And rejecting $\frac{1}{72}$ of itself
$\quad$ $2\frac{1}{2}$
we get 14 $6\frac{3}{4}$ Ans. to nearest farthing.

2. What amount daily will give £1359 yearly?

3)1359
453
906 count this pence
= 75·6*s.* rejecting 1*s.* $0\frac{1}{2}$*d.*
= £3, 14*s.* $5\frac{1}{2}$*d.* Ans. to the nearest farthing.

Exercise 84.

What amounts per day will give the following yearly incomes?—

	£	s.	d.		£	s.	d.		£	s.	d.
(1.)	100	0	0	(11.)	52	10	0	(21.)	1000	0	0
(2.)	155	0	0	(12.)	120	10	0	(22.)	2500	0	0
(3.)	180	0	0	(13.)	140	10	0	(23.)	3675	0	0
(4.)	209	0	0	(14.)	275	15	0	(24.)	7320	0	0
(5.)	250	0	0	(15.)	333	15	0	(25.)	8695	0	0
(6.)	300	0	0	(16.)	444	18	0	(26.)	4321	10	0
(7.)	350	0	0	(17.)	567	13	0	(27.)	3214	15	0
(8.)	389	0	0	(18.)	678	16	0	(28.)	2143	16	0
(9.)	763	0	0	(19.)	730	0	0	(29.)	78963	0	0
(10.)	684	0	0	(20.)	987	15	0	(30.)	54678	0	0

DISCOUNT AND PRESENT WORTH

All ordinary questions in Discount and Present Wor be solved by one of the forms given in Simple Intere another which is a modification of it. The rules given, fore, to find either the Discount or Present Worth dire be simple enunciations of these two formulas.

RULE LXXXV.

To find the present worth.

1°. Divide one hundred times the amount of the bill (amount due) by the sum of one hundred and the prod the Time and Rate.

Illustrative Example.—Find the Present Worth of £50 due six months hence at 4 per cent.

$$\text{P. W.} = \frac{100 \times £501\tfrac{1}{2}}{100 + (\tfrac{1}{2} \times 4)}$$

$$= £\frac{\overset{25}{\cancel{100}} \times \overset{59}{\cancel{1003}}}{\cancel{2} \times \underset{3}{\cancel{102}}}$$

$$= £\frac{25 \times 59}{3} = \underline{\underline{£491,\ 13s.\ 4d.}} \quad \text{Ans.}$$

Exercise 85.

		£	s.	d.			
(1.)	Find the P. W. of	5135	0	0	due in	219 days	@
(2.)	,, ,,	324	6	1¾	,,	2 yrs. 9 mos.	,,
(3.)	,, ,,	456	15	0	,,	4½ mos.	,,
(4.)	,, ,,	810	10	0	,,	3½ mos.	,,
(5.)	,, ,,	325	0	0	,,	12 mos.	,,
(6.)	,, ,,	1801	11	0	,,	6¼ years	,,
(7.)	,, ,,	553	15	0	,,	2 years	,,
(8.)	,, ,,	1886	16	0	,,	2 years	,,
(9.)	,, ,,	1516	11	5½	,,	1 yr. 219 dys.	,,
(10.)	,, ,,	911	13	3	,,	5 years	,,
(11.)	,, ,,	11040	0	0	,,	4 years	,,
(12.)	,, ,,	832	4	0	,,	4 years	,,

Rule LXXXVI.

To find the Discount.

1°. Divide the product of the Amount, Time, and Rate by the sum of one hundred and the product of the Time and Rate.

Illustrative Example.—Find the true Discount on £5994 due 2 years and 73 days hence at 5 per cent.

$$\text{Required Discount} = £\,\frac{5994 \times 2\frac{1}{5} \times 5}{100 + (2\frac{1}{5} \times 5)}$$

$$= £\,\frac{\overset{54}{\cancel{5994}} \times 11}{\cancel{111}}$$

$$= \underline{£594.} \quad \text{Ans.}$$

Exercise 86.

		£	s.	d.				
(1.)	Find the true Discount on	75	0	$1\frac{3}{4}$	due in	25 days	@	$7\frac{1}{2}$ °/ₒ.
(2.)	,, ,,	35	10	9	,,	7 mos.	,,	$4\frac{1}{2}$,,
(3.)	,, ,,	678	8	0	,,	$1\frac{1}{2}$ yrs.	,,	4 ,,
(4.)	,, ,,	10	0	0	,,	1 yr.	,,	10 ,,
(5.)	,, ,,	237	10	0	,,	2 yrs.	,,	7 ,,
(6.)	,, ,,	793	14	$10\frac{1}{2}$	,,	9 mos.	,,	4 ,,
(7.)	,, ,,	587	18	9	,,	6 mos.	,,	$4\frac{1}{2}$,,
(8.)	,, ,,	228	11	$5\frac{1}{4}$	,,	2 yrs.	,,	4 ,,
(9.)	,, ,,	16629	0	0	,,	5 yrs.	,,	3 ,,
(10.)	,, ,,	1236	5	0	,,	4 yrs.	,,	$3\frac{3}{4}$,,

CHAIN RULE AND BARTER.

By Barter is meant "Exchange in Kind," and such questions are solved by the ordinary rules of multiplication and division or by variation. The "Chain Rule," which is another form for Variation, is given below with illustrative examples.

RULE LXXXVII.—THE CHAIN RULE.

1°. Beginning with that term which is similar to the one sought, state the various equations in the question consecutively under each other. Each denomination will thus appear as antecedent and consequent, or on both sides and in connected order.

2°. The quotient obtained by dividing the product of the consequents in the right-hand column by the product of the antecedents in the left-hand column will be the answer required.

Note.—Care must be taken to have each antecedent and its own consequent reduced to or expressed in the same denomination.

Illustrative Examples.—No. 1. If 15 sheep are worth 3 cows, and 8 cows are worth 40 pigs, and 21 pigs worth 35 goats, also 120 goats worth 10 ponies, how many sheep should be given for 5 ponies?

The equations are as follow:—

$$\left.\begin{array}{rl} 15 \text{ sheep} &= 3 \text{ cows} \\ 8 \text{ cows} &= 40 \text{ pigs} \\ 21 \text{ pigs} &= 35 \text{ goats} \\ 120 \text{ goats} &= 10 \text{ ponies} \\ 5 \text{ ponies} &= ? \text{ sheep} \end{array}\right\} \text{ or } \frac{\overset{3}{\cancel{15}} \times \cancel{8} \times \overset{3}{\cancel{21}} \times \overset{4}{\cancel{120}} \times \cancel{5}}{\cancel{3} \times \cancel{40} \times \cancel{35} \times \cancel{10}} = \underline{\underline{36.}} \text{ Ans.}$$

No. 2. The first of 5 clerks can copy 3 lines as soon as the second can copy 4, the second can copy 5 as soon as the third can copy 3, the third can copy 7 as soon as the fourth can copy 8, and the fourth can copy 14 as soon as the fifth can copy 17. How many lines will the fifth copy while the first is copying 490?

$$\begin{array}{rl} 3 \text{ No. } 1 &= 4 \text{ No. } 2 \\ 5 \text{ No. } 2 &= 3 \text{ No. } 3 \\ 7 \text{ No. } 3 &= 8 \text{ No. } 4 \\ 14 \text{ No. } 4 &= 17 \text{ No. } 5 \\ ? \text{ No. } 5 &= 490 \text{ No. } 1 \end{array}$$

$$\frac{4 \times \cancel{3} \times 8 \times 17 \times \cancel{490}}{\cancel{3} \times \cancel{5} \times \cancel{7} \times \cancel{14}}$$

$$= 4 \times 17 \times 8$$

$$= \underline{\underline{544.}} \text{ Answer.}$$

Exercise 87.

(1.) If 4 lbs. of pork be worth $3\frac{1}{2}$ lbs. of beef, 3 lbs. of pork $= 2\frac{1}{3}$ lbs. of bacon, 10 lbs. of bacon $=$ 9 lbs. veal, 6 lbs. veal $=$ 5 lbs. cheese, how much cheese must be given for 4 lbs. beef?

(2.) If 2 doz. eggs $=$ 5 stones of salt $=$ 1 stone of flour, $3\frac{1}{2}$ stones flour $=$ 5 stones barley $=$ 7 lbs. of butter, how many eggs are worth 7 lbs. of butter?

(3.) If 14 gals. claret $=$ 18 gals. sherry, 3 gals. sherry $=$ 2 gals. brandy, 3 gals. brandy $=$ 5 gals. port, what quantity of port must be given for 42 gals. claret?

(4.) 3 yds. lace $=$ 81*s.*, 2 yds. lace $=$ 6 prs. gloves, 7 prs. gloves $=$ 3 pieces ribbon, 4 pieces ribbon $=$ 6 doz. prs. socks, what is the price of 4 doz. prs. socks?

(5.) If 10 lbs. in Cork $=$ 9 lbs. at Rotterdam, 98 at Rotterdam $=$ 116 at Frankfort, how much in Cork is equal to $119\frac{11}{35}$ lbs. at Frankfort?

(6.) If 4 lbs. currants $=$ 3*s.*, 5 lbs. currants $=$ 3 lbs. almonds, 4 lbs. almonds $=$ 10 lbs. raisins, $3\frac{1}{2}$ lbs. raisins $=$ 3 lbs. sugar, how many lbs. of sugar can I get for 1*s.* 9*d.*?

(7.) If £1 $=$ 25·5 francs, 55 florins $=$ 117 francs, and 26 marks $=$ 22 florins, how much English money shall I get for 170 marks?

(8.) If A digs 3 yds. whilst B digs 2, B digs 5 whilst C digs 6, C digs 7 whilst D digs 8, D digs 9 whilst E digs 10, E digs 15 whilst F digs 14, how many yds. will F dig whilst A digs 270?

(9.) If 15 scudi $=$ 81 francs $=$ 675 thalers, 62 scudi $=$ 135 gulden, 10 gulden $=$ £1, what number of thalers will be obtained for £4, 15*s.*?

(10.) If 12 cows be worth 29 sheep, 3 sheep $=$ 5 pigs, 17 pigs $=$ 3 horses, 8 horses $=$ 13 ponies, how many ponies must be given for 8160 cows?

(11.) If 25 thalers $=$ 93 francs, £6 $=$ 40 thalers, 27 francs $=$ 5 scudi, and 62 scudi $=$ 135 gulden, how many gulden $=$ £2?

EXCHANGE.

Exchange or Foreign Exchanges may be defined a monetary intercourse of nations. There are several r in which money obligations between merchants of diff countries are discharged. Thus A of London owing thalers to B of Berlin may pay either in specie (coined mc in bullion (bar gold or silver), or in bills (Bill of Excha If payment be made in specie or in bullion the "Par of change" must be taken into account. Silver is never exp or transmitted in specie. If A prefer payment by bil real rate of exchange between the two countries (detern by the balance of trade) or the "Course of Exchange decide the amount of the bill. It may, however, be more fitable for A not to transmit directly to B at Berlin, b adopt a circuitous route, remitting say to Paris, then Paris to Berlin, or from Paris to Madrid and thence to B This mode of payment is termed the Arbitration of Exch and is Simple or Compound according as "one" or "n places intervene. As all questions in Exchange can be s by the Rule of Variation, or generally more briefly b Chain Rule, any further exposition of the theory and ciples of Exchange is unnecessary. The student will fin the information he may require on this intricate subje *M'Culloch's Dictionary* and similar works. For the solu of "Exchange" questions the methods will be exhibite two or three examples.

Rule LXXXVIII.

To calculate questions in Exchange.

1°. Employ the rule of Variation; or, in questions of a complicated character, take advantage of the Chain Rul *explained* in the immediately preceding pages.

Illustrative Examples.—1. What must I give for 1000 francs when 25·6 francs are worth 20 shillings?

$$\text{The question is if}\quad \left.\begin{array}{rl} 25\cdot6\ \text{fr.} = 20s. \\ 1000\ \ \text{fr.} = \ ? \end{array}\right\}\ \begin{array}{l}\text{by rule of}\\ \text{Variation,}\end{array}$$

$$\text{we have}\quad \frac{\overset{5}{\cancel{20}}\times1000}{\underset{6\cdot4}{\cancel{25\cdot6}}}s. = \frac{50000}{64}s. = \frac{6250}{8}s. = 781s.\ 3d.$$

$$= \underline{\pounds39,\ 1s.\ 3d.}\quad \text{Ans.}$$

2. If 60 kreutzers are equal to a florin, and 420 kreutzers equal to 15 francs, find the value in English money of 2261 florins (£1 = 25·5 francs)?

Adopting the Chain Rule our statement is:

$$\left.\begin{array}{rcl} 1\ \text{florin} & = & 60\ \text{kreutzers} \\ 420\ \text{kreutzers} & = & 15\ \text{francs} \\ 25\cdot5\ \text{francs} & = & 1\ \text{pound sterling} \\ ?\ \pounds & = & 2261\ \text{florins} \end{array}\right\}\ \text{or}$$

$$\pounds\frac{60\times15\times2261}{420\times25\cdot5} = \pounds\frac{\cancel{60}\times\overset{10}{\cancel{150}}\times\overset{\overset{19}{\cancel{323}}}{\cancel{2261}}}{\underset{\cancel{7}}{\cancel{420}}\times\underset{\cancel{17}}{\cancel{255}}} = \underline{\underline{\pounds190.}}\quad \text{Ans.}$$

Exercise 88.

(1.) A bill upon Amsterdam is bought for 12 florins per £1 sterling, the proceeds purchase at Amsterdam bills upon Hamburg @ 34¼ florins for 40 marks, these are forwarded to Paris and sold at 185 francs per 100 marks. What is the rate of exchange between London and Paris?

(2.) A person enters France with 33 sovereigns 1 half-sovereign and 7 florins. He spends 577 francs 50 centimes. How many florins will he receive in exchange for the remainder? (£1 = 26 francs 25 centimes.)

(3.) If 6⅔ thalers be equal to £1 and 93 francs equal to 25 thalers, also 5 scudi be worth 27 francs and 135 gulden be of the same value as 62 scudi, find how many gulden must be given for £10.

(4.) How many pence per milree (= 1000 rees) is the exchange between Portugal and Britain, when £823, 5*s.* 6*d.* worth of wine costs 3161 milrees 375 rees?

(5.) Find the relation between the sovereign and the napole as determined from the intrinsic value of the two coi (1.) 40 lbs. British standard gold, $\frac{11}{12}$ fine, is coined in 1869 sovereigns. (2.) 1 kilog. French standard gol $\frac{9}{10}$ fine, is coined into 155 napoleons. (3.) Kilog 15432 grains.

(6.) A in Boston (U.S.) remits 5110 dollars to London (a doll = 4*s*. 6*d*. English): for what sum in English money d he draw his bill when bills *on* London are at a premiu of 9½ %?

(7.) If at Paris the exchange upon London is at the rate 25 francs 70 centimes for £1, and the exchange at Mil upon Paris is 42 Austrian lire for 20 francs, wh Austrian money should be given for a £10 note?

(8.) A trader in London owes 1000 pistoles to another trad in Cadiz: find what he gains by sending it throu France, the exchange being £1 = 25·4 francs, 19 fran = 1 Spanish pistole, 4 Spanish pistoles = £3.

(9.) A Londoner owes a Russian at St. Petersburg 920 roubl which must be remitted through Paris. He pays to l broker the requisite sum when 25·15 francs = £1 a 1·2 francs = 1 rouble. The remittance is delayed a the rates become 25·35 francs = £1 and 1·15 francs f 1 rouble. What does the broker gain or lose by t delay?

(10.) A person in London owes another in Moscow 460 roubl to be remitted through Paris. The amount is paid the broker when 23 francs = £1 and 2 francs for 1 roubl but remittance is delayed until rates are 24 francs f £1 and 3 francs for 2 roubles. What does the broke lose or gain by the delay?

FELLOWSHIP.

Fellowship or Partnership is the rule for dividing Profit o Loss among partners. It is Simple and Compound.

Rule LXXXIX.

To find the Profit or Loss payable by each partner whe only one consideration enters (Simple Fellowship).

1°. Add the various contributions together.

2°. *Divide* the total gain or loss by this sum.

3°. Multiply each partner's share or contribution by the quotient for the several answers.

Illustrative Examples.—1. A, B, and C go into partnership. A puts in £4189, B puts in £4779, and C puts in £5369. The profit is £1701. What is each person's share?

$$\text{By } 1^\circ \quad (4189 + 4779 + 5369) = £14337$$

$$\begin{array}{lrl} \therefore \text{ by } 2^\circ \text{ and } 3^\circ & \text{A's share} & = £\dfrac{1701 \times 4189}{14337} = £(7 \times 71) = \underline{\underline{£497}}: \\ & \text{B's} \quad ,, & = £\dfrac{1701 \times 4779}{14337} = £(7 \times 81) = \underline{\underline{£567}}: \\ & \text{C's} \quad ,, & = £\dfrac{1701 \times 5369}{14337} = £(7 \times 91) = \underline{\underline{£637}}. \end{array}$$

2. A, B, C, and D rent a field for £41, 9*s.* 6*d.* A puts in 237 sheep, B 158, C 316, and D 395. What is each person's share of the rent?

By 1° $237 + 158 + 316 + 395 = 1106$: and £41, 9*s.* 6*d.* = 9954 pence

$$\text{then} \quad \frac{9954}{1106} = 9$$

$$\begin{array}{llrrrr} & & & £ & s. & d. \\ \therefore \text{by } 2^\circ \text{and } 3^\circ & \text{A's share} = (9 \times 237)d. = & & 8 & 17 & 9 \\ & \text{B's} \quad ,, \quad = (9 \times 158)d. = & & 5 & 18 & 6 \\ & \text{C's} \quad ,, \quad = (9 \times 316)d. = & & 11 & 17 & 0 \\ & \text{D's} \quad ,, \quad = (9 \times 395)d. = & & 14 & 16 & 3 \end{array} \left.\vphantom{\begin{array}{l}1\\1\\1\\1\\1\end{array}}\right\} = £41,\ 9s.\ 6d.$$

Exercise 89.

(1.) A is a working, B a sleeping, partner in a business. A has £1200 of the capital, B £2000. A receives 10 per cent of all the profits for managing, the rest being proportionately divided. Find their respective shares of £800 profit in the year.

(2.) A and B are in partnership. A's capital is £5000, B's £7500. The gross receipts are £3200; one-eighth of this is paid as salaries to clerks; £30 is paid as insurance. A is to receive 8 per cent on his capital and B 4 per cent, the remainder of the profit to be divided in proportion to their capital. Find the net receipts of A and B.

(3.) Three partners invest £3000, £1200, and £2000 respectively. The profits on the business for the year are £744. Find each share.

(4.) A, B, C divide their profits, which amount to 1678 guineas in the proportion 6 to 7 to 8. Calculate each partner' share.

(5.) A and B join in a picnic, each paying for the guests h invites. A invites 15 and B 10. The whole cost i £6, 18*s.* 6½*d.* On the day B pays for the carriages a 2*s.* 6*d.* per head for the whole party, and A pays all th other expenses. How must they afterwards settle wit each other?

(6.) A, B, and C enter into partnership. A's capital is £210 B's £1500, and C's £1800. At the year's end th profits are found to be 10 per cent on gross capita invested. Calculate each share.

(7.) A and B enter business together. A gives ⅗ of capital At the end of first year they have made 3½ per cen profit, at the end of the second year 5 per cent, at th end of the third year they are bankrupt, paying 10*s.* i the pound. The remaining money is £16,663, 10*s.* Ho much did each contribute?

When an additional element (generally of time) is introduced the question becomes one of Compound Fellowship.

RULE XC.

To find the Profit or Loss to each partner where more than one consideration is introduced.

1°. Multiply each partner's contribution by the time during which it is invested.

2°. Add all these products together.

3°. Divide the loss or gain by this sum and multiply each partner's product by this quotient for his share.

Illustrative Examples.—1. A, B, and C go into partnership. A puts in £700 for 12 months, B puts in £1150 for six months, and C puts in £1400 for 9 months. The profit made during the year is £1395. What is each person's share o the gain?

$$\left.\begin{array}{l} A = 700 \times 12 = 8400 \\ B = 1150 \times 6 = 6900 \\ C = 1400 \times 9 = \underline{12600} \\ \underline{\underline{27900}} \end{array}\right\} \quad \begin{array}{l} \therefore A = £\dfrac{1395 \times 8400}{27900} = \underline{\underline{£420.}} \\ B = £\dfrac{1395 \times 6900}{27900} = \underline{\underline{£345.}} \\ C = £\dfrac{1395 \times 12600}{27900} = \underline{\underline{£630.}} \end{array}$$

2. In a certain business A contributes £500 for 10 months, and B £625 for 12 months. The gross profit is £3200. One-eighth of this is paid as clerks' salaries, and £30 is spent in insurance of the premises. A is to receive 8 °/₀ per month on his capital, and B 4 °/₀ per month on his contribution. The rest of the gain is divided between the partners in proportion to the amounts of their capitals and the times of investment. Find the net receipts of A and B.

Clerks' salaries = £3200 ÷ 8	=	£400
Insurance on premises	=	30
A's interest = (£500 × 10 × 8) ÷ 100	=	400
B's „ = (£625 × 12 × 4) ÷ 100	=	300

$$\therefore \text{£}3200 \sim (\text{£}400 + 30 + 400 + 300) = \text{£}3200 \sim 1130$$
$$= \text{£}2070.$$

Wherefore residue to be divided = £2070.

Now A's share will be $(\text{£}500 \times 10) \div 12500 = \frac{2}{5}$
and B's „ „ $(\text{£}625 \times 12) \div 12500 = \frac{3}{5}$
$\therefore$ $\frac{2}{5}$ of £2070 = £(2 × 414) = £828 = A's share
and $\frac{3}{5}$ „ = £(3 × 414) = £1242 = B's „

Consequently A's net income will be £(828 + 400) = £1228.
„ B's „ „ £(1242 + 300) = £1542.

Exercise 90.

(1.) A and B rent a field for £138 yearly. A puts in 200 sheep and B 160. At the end of six months they dispose of half their stock and allow C to put in 120. What should they severally pay at the end of the year?

(2.) The rent of a field is £5, 12*s.* 6*d.* annually. A feeds on it 6 cows for 8 months, B 9 cows for 6½ months, C 7 cows for 10½ months. What should each pay of the rent?

(3.) A, B, and C rent a field for £69, 13*s.* 4*d.* A puts in 3 cows for 3 months and 25 sheep for 4 months, B puts in 7 cows for 4 months and 15 sheep for 2 months, C puts in 5 cows for 3 months and 20 sheep for 4 months. Supposing a cow to eat as much as 4 sheep, what is each man's share of the rent?

(4.) A, B, and C enter into partnership with capitals which are as 1 to 2 to 3. In 6 months A withdraws half his capital, but restores it after 3 months more. At the end of 4 months from the commencement B withdraws $\frac{1}{3}$ of his capital, and 2 months later C adds twice as much as B withdrew. How should a profit of £658, 10*s* be divided at the end of the year?

(5.) A and B rent a field for £81. A puts in 69 horses for 9 months and B 63 horses for 13 months. What should each pay?

(6.) A and B enter into partnership. A puts in $\frac{4}{9}$ of the capital. At the end of 3 months A withdraws $\frac{2}{3}$ and B $\frac{3}{8}$ of their capital respectively. The profit at the end of the year is £436, 9*s*. 6*d*. Calculate each partner's share of the profits.

STOCKS.

Stock has already been defined as the trading capital of a government or company. It is not necessary, nor would it be advisable to supply here an elaborate or exhaustive essay on Stocks, including the technical terms and speculative transactions of the Stock Exchange. Suffice it to say that shares are like any other marketable commodity, and that whilst they are *in*variable as to the amount of Stock they severally represent, they are *most* variable in their market values or prices. No general rule can be framed to solve questions in Stocks, but they can all be worked by the Fractional Form and the rule of Variation. When £100 of stock is worth £100 in the market the shares are "*at par.*" When the price is less than the amount of stock the shares are "*at a discount;*" and when £100 of stock will command a market price of more than £100 the share is "*at a premium.*"

Shares may be transferred, *i.e.* bought or sold either with or without the aid of a broker. A broker may be termed a Commission Agent in Stocks and Shares.

If the methods of solution furnished below are carefully followed, no questions in Stocks will present insurmountable obstacles to the student.

Brokerage is generally one-eighth per cent on the amount of stock transferred, and has nothing whatever to do with, and is nowise affected by, the market value of the stock or shares. Brokerage always increases one's buying price and decreases one's selling price.

The subjoined formulas will solve the great majority of *problems* under this heading, and the student is recommended to study them carefully. In these formulas V stands for the market *V*alue of the shares; M represents the purchase *M*oney; S the amount of *S*tock; R the *R*ate °/₀; I the *I*ncome derived from any investment; and N the *N*umber of shares under consideration, in possession, or to be found.

$$(1.)\quad S=\frac{M\times 100}{V}.$$

$$(2.)\quad M=\frac{S\times V}{100}.$$

$$(3.)\quad I=\frac{M\times R}{V}.$$

$$(4.)\quad M=\frac{I\times V}{R}.$$

Illustrative Examples.—1. What amount of stock can be purchased in the 3 per cents for £2094 at $87\frac{1}{4}$?

(Formula 1 is employed in this question.)

The articles (shares) we want to buy are quoted at £$87\frac{1}{4}$ each and we have £2094 to invest. Obviously the number we can purchase is found by dividing our capital by the price per share. Then as each share represents £100 of stock, the product of £100 and the number bought will be the answer sought.

$$\text{No. of shares purchased} = \frac{2094}{87\frac{1}{4}}$$

$$\text{and amount of stock bought} = \frac{2094\times 100}{87\frac{1}{4}} = \frac{2094\times 400}{349}$$

$$= \underline{\underline{\pounds 2400 \text{ Stock.}}} \quad \text{Ans.}$$

2. How much will be realized by selling £5550 of stock in the $3\frac{3}{4}$ per cents, at $89\frac{1}{2}$?

$$\text{No. of shares disposed of} = \frac{5550}{100} \text{ by Formula 2,}$$

$$\text{therefore}\quad \frac{5550\times 89\frac{1}{2}}{100} = 55\frac{1}{2}\times 89\frac{1}{2} = \underline{\underline{\pounds 4967,\ 5s.\ 0d.}} \quad \text{Ans.}$$

3. What income does a man secure by investing £3220 in the $3\frac{1}{2}$ per cents at $80\frac{1}{2}$?

$$\text{No. of shares that can be bought} = \frac{3220}{80\frac{1}{2}} \text{ by Formula 3,}$$

$$\text{therefore}\quad \frac{3220\times 3\frac{1}{2}}{80\frac{1}{2}} = \frac{3220\times 7}{161} = \underline{\underline{\pounds 140 \text{ Income.}}} \quad \text{Ans.}$$

4. What must be paid for £1500 stock in the 3 per c at 89⅞, brokerage ⅛ °/o, and what interest is obtained?

No. of shares to be bought $= \frac{1500}{100} = 15,$

then the absolute price of shares will be $89\tfrac{7}{8} + \tfrac{1}{8} = 90,$

$\therefore\ 15 \times £90 = £1350 =$ amount required,

or by Formula 2, $M = \frac{S \times V}{100} = \frac{15\cancel{00} \times 90}{1\cancel{00}} = \underline{\underline{£1350.}}$ Ans. (

Lastly, if $£90 = £3$ interest
$£100 = ?$ „ $\frac{3 \times 100}{90} = \frac{10}{3} = \underline{\underline{3\tfrac{1}{3}\ {}^\circ\!/_\circ}}.$ Ans.

5. A person holds £4450 in Turkish bonds. He sells o 52⅛ and invests the proceeds in the 3 per cents at 88⅞. W will be his income? (Brokerage on both transactions ⅛ °/

The actual selling price will be 52,

$\therefore$ money realized by sale is $(£4450 \div 100) \times 52.$

The actual buying price in the 3 per cents is 89,

$\therefore$ number of shares bought in $3\ {}^\circ\!/_\circ = \frac{4450 \times 52}{100 \times 89};$

and as each share brings in £3 interest

the new income will be $£\frac{\overset{50}{\cancel{4450}} \times \overset{26}{\cancel{52}} \times 3}{\underset{2}{\cancel{100}} \times \cancel{89}}$

$= £26 \times 3 = \underline{£78.}$ Ans.

6. Which is the better investment, the 3¼ per cents @ or the 3½ per cents @ par?

$\frac{3\frac{1}{4}}{92\frac{5}{8}} =$ what £1 will yield in 1st investment

$\frac{3\frac{1}{2}}{100} =$ „ „ 2nd „

$\therefore\ \frac{3\frac{1}{4}}{92\frac{5}{8}} \gtrless \frac{3\frac{1}{2}}{100}$ as $\frac{\frac{13}{4}}{\frac{741}{8}} \gtrless \frac{\frac{7}{2}}{100}$

as $\frac{26}{741} \gtrless \frac{7}{200}$

as $5200 \gtrless 5187.$

Consequently the first is the better investment.

Exercise 91.

(1.) A transfers £1234 stock from 3¼ $^\circ/_\circ$ @ 88⅞ to the 3½ $^\circ/_\circ$ @ 95⅔. Find the difference in his income.

(2.) What will £1500 stock in the 3 $^\circ/_\circ$ @ 89⅞ (brokerage ⅛ $^\circ/_\circ$) cost, and what interest per cent will be obtained by the outlay?

(3.) B holds £4450 in the Turkish stocks. He sells out at 52⅛ and invests proceeds in reduced 3 $^\circ/_\circ$ @ 88⅞. What will be his income, brokerage ⅛ $^\circ/_\circ$ on each transaction?

(4.) Which is the better investment, the 3¼ @ 92⅝ or the 3½ at par?

(5.) What income does B secure by investing £3220 in the 3½ $^\circ/_\circ$ @ 80½; the stock rises to 92 and he sells out? At what price must he buy into the 4 $^\circ/_\circ$ that he may increase his income by £10?

(6.) Which is more advantageous, the 4 $^\circ/_\circ$ @ 120 or the 2½ $^\circ/_\circ$ @ 75?

(7.) Compare the income from £500 invested in 3 $^\circ/_\circ$ @ 90 and the simple interest of same sum for same period and at same rate.

(8.) Find price of 3 $^\circ/_\circ$ stock when an investment of £434,12*s*.6*d*. produces an income of £14, 5*s*. 0*d*.

(9.) A sells £1000 @ 91 out of the 3 $^\circ/_\circ$ and invests proceeds @ 5 $^\circ/_\circ$. What is the difference in his income?

(10.) Three per cent stock bought @ 91⅞ is held for 7 months and 2 dividends are received, it is then sold at same price (brokerage ⅛ $^\circ/_\circ$). What is the rate $^\circ/_\circ$ gained by the transfer (transaction)?

(11.) A invests £25,935 in the 3 $^\circ/_\circ$ @ 90, what is his income? If 1st year's dividend be invested in same stock @ 91 and the whole dividend of 2nd year @ 95, what will income of 3rd year amount to?

(12.) What change of income results from selling out of the 1¾ $^\circ/_\circ$ @ 47¼ and buying in the 3⅔ @ 99?

(13.) How much 3½ $^\circ/_\circ$ stock @ 97¾ can be got for £3519, and what is the income therefrom?

(14.) A invests £1695, 16*s*. 8*d*. in the 3½ $^\circ/_\circ$ @ 101¾ and £1767, 3*s*. 9*d*. in the 3 $^\circ/_\circ$ @ 94¼; what is the difference of income accruing from both investments?

(15.) A sells out £10,000 in 3 $^\circ/_\circ$ @ 94½, buys in the 4 $^\circ/_\circ$ @ 105; required change in his income.

(16.) A sells £43,400 stock in 3 °/₀ @ 96, buys in 6 °/₀ @ 10
What is the difference in his income?

(17.) A invests £7560 in the 3 °/₀ @ 94½, and when the fund
fall to 90 he sells out a quarter of his stock. H
subsequently sells the remainder of his stock at 94
How is his capital affected?

(18.) B invests £1210 in the 3¼ °/₀ @ 97½ and an equal sum i
the 5 °/₀ @ 90¾. What is his combined income?

(19.) What amount must be invested in 3 °/₀ @ 92½ to get th
same income as £1530 invested in the 3½ @ 95 woul
procure?

(20.) A finds that his capital in the 6 °/₀ @ 132 secure
£10, 16*s.* 0*d.* more than when invested in 3 °/₀ @ 9
Find his capital.

(21.) What amount will buy £8000 stock @ 92¾ and pa
broker ⅛ °/₀?

(22.) B wants an income of £100 from investment of £266
13*s.* 4*d.* in 3 °/₀, at what price must he buy in?

(23.) A invests half his capital in 3 °/₀ @ 91, and the othe
half in the 4 °/₀ at par, which is more advantageous
and if his total income from both sources be £500, wha
is his capital?

(24.) A invests £153, 14*s.* 4*d.* in 3½ °/₀ @ 92 and £184, 12*s.* 6½
in 2½ °/₀ @ 85. Show that this is the same as investin
the whole amount in the 3 °/₀ @ 90.

(25.) B invests £1274 in 3½ °/₀ @ 91, find the income.

(26.) What income results from the investment of £3410 i
3 °/₀ @ 93 after deduction of an income-tax of 5*d.* i
the £1?

(27.) A invests £4700 in 3½ °/₀ @ 98 and same amount in 3 °/
@ 94, what difference would it have made had h
invested the whole in the 3½ °/₀?

(28.) A invests £1365 in the 3 °/₀ @ 91; sells out £1000 stoc
@ 93½, and the remainder when the stock is @ 8
What does he gain or lose by the transaction?

(29.) I buy 10 shares of £20 for 27½ each, receive a dividen
of 15 °/₀, and sell out @ 37½; how much have I gaine
in all?

(30.) If the 3 °/₀ Consols be @ 90⅝, what must I invest to secu
£470 income, after paying an income-tax of 5*d.* in th
pound and broker ⅛ °/₀?

1.) A receives $3\frac{1}{3}$ °/o for his money in the 3 °/o Consols, what was the price of the stock?

2.) What is the gain by investing £1950 @ $97\frac{3}{8}$ and selling out @ 104, brokerage $\frac{1}{8}$ °/o on each transaction?

3.) A man invested a sum of money in the 3 °/o @ 88, and at the end of $4\frac{1}{2}$ months, after receiving half-yearly dividend, sold out at $87\frac{7}{8}$. What rate °/o did he get on his capital?

4.) A deriving all his income from a railway investment paying 4 °/o on his capital, spends $\frac{2}{3}$ of his income, and pays an income-tax of 6*d.* in the pound. Next year the railway dividends are $4\frac{1}{2}$ °/o, his personal expenses are 10 °/o more, and the income-tax is reduced 4*d.* in the pound. His income is £5 more than in previous year; find his original income.

5.) Having a certain sum to invest I find that an investment in a railway preference 5 °/o stock @ $117\frac{1}{2}$ will give £29 more interest annually than the 3 °/o Consols @ $92\frac{1}{4}$. Find my capital.

6.) Which is the better investment, the 3 °/o @ $64\frac{1}{4}$ or the 5 °/o @ $102\frac{3}{4}$? What will be the difference of income from £1000 invested in each?

37.) Half of a certain sum is invested in 3 °/o @ 90 and the other half in 5 °/o @ 110; the total income is £6883, 10*s.* What is the capital?

38.) An investment of £7440 is made in the 3 °/o @ $92\frac{7}{8}$ 2 months before dividend is paid; immediately after dividend is received the stock is sold out @ 92; brokerage being $\frac{1}{8}$ °/o on both transactions find rate of interest obtained by the purchase and sale.

(39.) A man has stock in the 3 °/o bringing him in £240 a year. He sells out $\frac{1}{4}$ of his stock @ $87\frac{1}{4}$ and invests the proceeds in railway stock @ £$174\frac{1}{2}$. What dividend ought railway stock to pay that he may increase his income £40?

(40.) A invests £5460 in the 3 °/o @ 91 and sells out £200 stock when they have risen to $93\frac{1}{2}$ and the remainder when they have fallen to 85. How much does he lose or gain by the transaction; and if he invests the proceeds in the $4\frac{1}{2}$ °/o @ 102, what will be the difference in his income?

PROFIT AND LOSS.

The method of dealing with questions under this head
be learned from the following problems. No rule could
elaborated that would apply universally, but the employm
of the fractional form will be found preferable in the gr
majority of questions. When working at this rule it m
ever be borne in mind that Profit and Loss are calcula
from the Prime Cost, and that Prime Cost must always
considered as 100.

Illustrative Examples.—1. Goods are sold for 12 guin
gaining $22\frac{38}{41}$ °/₀, what was the prime cost?

The statement is $252s. = 100 \text{ (or P.C.)} + 22\frac{38}{41} = 122\frac{38}{41}$
$? = 100.$

Reducing to fractional form

$$\frac{\overset{5}{\cancel{252}} \times \cancel{100} \times 41}{\underset{\cancel{20}}{\cancel{5040}}}s. = 41 \times 5s. = 205s. = \underline{£10,\ 5s.\ 0d.} \quad \text{Ans.}$$

2. By selling an article for 5*s*., 5 °/₀ loss is involved. Wl
must be the selling price to gain 4½ °/₀?

The statement is $60d. = 100 \text{ (P.C.)} \sim 5 = 95$
$? = 100 \text{ (P.C.)} + 4\frac{1}{2} = 104\frac{1}{2}.$

Reducing to fractional form

$$\frac{60 \times 104\frac{1}{2}}{95}d. = \frac{\overset{6}{\cancel{60}} \times \overset{11}{\cancel{209}}}{\cancel{2} \times \cancel{95}}d. = 6 \times 11d. = 66d. = \underline{5s.\ 6d.} \quad \text{Ans.}$$

3. A horse was sold for £24, 12*s*. 0*d*. at a loss of 18
What did the animal originally cost?

The statement is $24\frac{3}{5} = 82$
$? = 100.$

$$£\frac{\overset{3}{\cancel{123}} \times \overset{10}{\cancel{100}}}{\cancel{5} \times \underset{\cancel{2}}{\cancel{82}}} = \underline{£30.} \quad \text{Ans.}$$

4. A person bought a Geneva watch and sold it at a gain of 10 °/ₒ. If he had sold it for £8 less he would have lost 6 °/ₒ. What was the manufacturer's price for the watch, supposing a duty of 20 °/ₒ to be paid by the importer?

By the sale of the watch the *buyer* gets $\frac{110}{100}$ of his P.C.

$$\text{but } \pounds 8 \text{ less} = \tfrac{94}{100} \text{ of P.C.}$$

$$\therefore\ \pounds 8 = \tfrac{16}{100} \quad \text{''}$$

and by Variation

$$\text{cost price} = \pounds 50$$

but by question $\pounds 50 = 100 + 20 = \frac{120}{100}$ of manufacturer's price

$$\therefore\ \pounds\frac{\overset{25}{\cancel{50}} \times \overset{5}{\cancel{100}}}{\underset{\underset{3}{\cancel{6}}}{\cancel{120}}} = \pounds\frac{125}{3} = \underline{\underline{\pounds 41,\ 13s.\ 4d.}}\quad \text{Ans.}$$

Exercise 92.

(1.) If 5½ °/ₒ be gained by selling 121 yds. for £26, 11*s.* 10¾*d.*, at what price per yard must it be sold to gain 12 °/ₒ?

(2.) A horse cost £75, 10*s.* 0*d.*, is sold at a profit of 5¼ °/ₒ, find selling price.

(3.) 600 yds. were bought @ 3*s.* 4½*d.* per yd.; 360 yds. were sold @ 4*s.* 6*d.* per yd.; 81 yds. @ 3*s.* 9*d.* per yd.; the rest was lost. What was the gain or loss per cent?

(4.) A buys milk @ 2½*d.* per qt.; he dilutes and sells at 3*d.* per qt.; his profits are 60 °/ₒ on his outlay. How much water goes to each quart of milk?

(5.) A grocer buys 6½ cwts. tea @ 17 guineas per cwt.; he sells 3 cwts. of it @ 3*s.* 3*d.* per lb., and the remainder at 3*s.* 9½*d.* per lb. What is his gain per cent?

(6.) If 20 °/ₒ be lost on a horse sold for £19, 4*s.* 0*d.*, what did it cost?

(7.) Ten tons bought @ £1, 7*s.* 6*d.* per cwt. are sold at £30 per ton, what is the gain °/ₒ?

(8.) A dealer buys goods for £1050 and sells for £867 six months after, calculate the loss per cent.

(9.) A grocer buys 1 cwt. sugar for £1, 13*s.* 4*d.* and sells it for £2, 2*s.* 6*d.*, what is his gain °/ₒ?

(10.) By selling a horse for £73, 3*s.* I should lose 5 °/ₒ, at what price must I sell it to gain 15 °/ₒ?

(11.) A bought 240 cows @ £14, 6*s.* 0*d.* each, their freight c $\frac{1}{22}$ of the outlay; he then exchanged them for ponies which he sold @ £15 each. What was gain °/o?

(12.) A grocer has a quantity of tea which he must sell 3*s.* 6*d.* per lb. to gain 40 °/o. If he mix it with 2*s.* tea in ratio of 7 superior to 3 inferior, and sells t mixture in 10-lb. packets @ £1, 12*s.* 4*d.*, how mu does he gain °/o?

(13.) A tradesman who makes 10 °/o on his capital allows in the shilling discount off the price marked on ea article. How much above cost price does he mark t articles for sale?

(14.) If articles be retailed @ 3*s.* 6*d.* each, what must have be the cost price per score to realize a profit of 5 °/o?

(15.) By selling a house for £994, 10*s.* I gain 17 °/o on the c price. What should I have received had I lost 17 on the cost price?

(16.) If goods bought @ £114, 13*s.* 4*d.* per ton be retailed 17*s.* 11*d.* per stone, what is the rate of profit °/o? A if 10 °/o discount off the selling price be allowed w will the profit then be °/o?

(17.) If tea bought at 3*s.* 4*d.* per lb. be sold for 3*s.*, what is t loss °/o? And if 42 lbs. @ 3*s.* 4*d.* be mixed with 1 lbs. bought @ 2*s.* 6*d.*, and the mixture be sold at 3*s.* p lb., what will be the gain °/o?

(18.) If 5 °/o be gained by selling sugar @ 5¼*d.* per lb., what the cost price per cwt.? And what would be the gain if 3 cwts. 2 qrs. 26 lbs. 4 oz. were sold for £10, 9*s.* 1½

(19.) If 174 lbs. 6 oz. be bought for £52, 11*s.* 5*d.*, and 12 °/o the whole be allowed for waste, at how much per must the remainder be sold to gain 12½ °/o?

(20.) A mixture of tea is formed by mixing one chest of 2 q 17 lbs. @ 3*s.* 1½*d.* per lb. with two chests each contai ing 3 qrs. 7 lbs. @ 3*s.* 5½*d.* If the mixture be so @ 4*s.* per lb. what is gained °/o?

(21.) A buys sugars at 7*d.* and 10*d.* per lb. and mixes them the proportion of 3 to 5. What will he gain °/o by selli the mixture at 9*d.* a lb.?

(22.) From a Frenchman A buys a watch bearing a duty 25 °/o, and sells it at a loss of 5 °/o: had he sold it for more he would have cleared 1 °/o on his bargain. W had the Frenchman for it?

(23.) A person bought an article and sold at a gain of 5 °/₀. If he had bought it at 5 °/₀ less and sold it for 1*s.* less he would have gained 10 °/₀. Find cost price.

(24.) A person by selling an article which cost £14 per cwt. @ 2*s.* 9$\frac{3}{4}$*d.* per lb. makes 5 °/₀ more profit than he would do if he sold the whole for £55, 15*s.* 3$\frac{3}{4}$*d.* What was the amount sold?

(25.) A factor buys 2400 qrs. of corn. He sells $\frac{3}{5}$ of it at a profit of 12$\frac{1}{2}$ °/₀, $\frac{1}{4}$ at a profit of 15 °/₀, and the rest at cost price. Had he sold the entire quantity at a profit of 10 °/₀ he would have made £47, 5*s.* 0*d.* less. Find the cost of the barley.

EQUATION OF PAYMENTS.

It often happens that an individual owes several amounts payable at different times to the same person, and it is required to find a time when all the debts may be simultaneously discharged by one payment without loss to either party. The date so obtained is called the Equated Time.

RULE XCIII.

To find the Equated Time.

1°. Multiply each amount by the time that will elapse before it becomes due. (Time in every case being either ALL days, all months, or all years, &c.)

2°. Divide the sum of these products by the sum of the amounts, and the quotient will be the Equated Time.

Illustrative Example.—A owes £293 due 6 months hence, £28 due 4 months, £32 due 2 months, and £26 due 5 months. In what time may all four bills be discharged by one payment?

$$\begin{array}{r|r}
293 \times 6 = & 1758 \\
28 \times 4 = & 112 \\
32 \times 2 = & 64 \\
26 \times 5 = & 130 \\
\hline
379 & 2064 \\
\hline
5\frac{169}{379} & 169
\end{array}$$

or nearly 5$\frac{1}{2}$ months.

Say $\underline{\underline{5\frac{169}{379}\text{ months}}}$.

Exercise 93.

(1.) Find the sum which, paid one year hence, will be an ec valent for £200 due now and £600 due at the enc 2 years, the rate of interest being 5 per cent.

(2.) One person owes another £50 payable in 6 months, . payable in 8 months, and £90 payable in 4 mon At what time may all be paid without loss or gain?

(3.) Find what sum paid 2 years hence will be an equival for £100 due 1 year hence and £500 due 3 years hei rate of interest being 5 per cent.

(4.) A owes B £320 due in 2 months, £160 due in 4 mon £240 due in 5 months, and £400 due in 6 mon When may he justly pay all the debts at once?

(5.) A owes £4800 to B, of which £1600 is due at once, £1 due in 3 months, £1200 in 6 months, and £800 i months. Find equated time of payment.

(6.) £80 are payable in 4 months, £90 in 8 months, £7(6 months, and £120 in 10 months. When may whole be discharged in one payment?

(7.) One-fifth of a debt is payable in 16 months, $\frac{1}{4}$ in months, $\frac{1}{2}$ in 10 months, and the remainder in months. When may the whole debt of £2000 be p at once?

(8.) £600 payable in 10 months, £800 in 9 months, £70(6 months. Required equated time.

TARE AND TRET.

It will be sufficient to direct the scholar's attention to definitions (pages 40–42) of the various terms used (such Tare, Tret, Suttle, Gross, Net, &c.), and to the methods hibited in the illustrative examples.

Illustrative Examples.—1. Calculate the tare on 4 tons cwts. 2 qrs. @ 14 lbs. per cwt.

4 tons = 80 cwts. ∴ entire quantity = 90 cwts. 2 qrs.

∴ required tare = $(90\frac{1}{2} \times 14)$ lbs. = 1267 lbs. = 11 cwts. 1 qr. 7 lbs.

2. Calculate the entire allowances on 104 casks, each 2 c *2 qrs. gross*; tare 4 lbs per cask and tret as usual.

(*a*) 104 × 2 cwts. 2 qrs. = 104 × 10 qrs. = 104 × 280 lbs. = 29120 lbs. = gross weight.

(*b*) Tare = 8 × 104 lbs. = 832 lbs. ∴ gross ~ tare = 29120 ~ 832 = 28288 lbs.

(*c*) Tret = $\frac{1}{26}$ of 28288 lbs. = 1088 lbs.

∴ tare + tret = 832 + 1088 = 1920 lbs. = $\underline{\underline{\text{17 cwts. 16 lbs.}}}$

3. Find the tare, the tret (usual rate), and the net weight of 36 boxes, each 4 cwts. 2 qrs. 15 lbs. gross. Tare 25 lbs. per box.

(*a*) Gross = 4 cwts. 2 qrs. 15 lbs. × 36 = 36 × 519 lbs. = 18684 lbs.

(*b*) Tare = 25 lbs. × 36 = $\underline{\underline{900}}$ lbs. Ans. (1).

(*c*) Suttle = (18684 ~ 900) lbs. = 17784 lbs.

(*d*) Tret = $\frac{1}{26}$ of 17784 lbs. = $\frac{1}{13}$ of 8892 lbs. = $\underline{\underline{\text{684 lbs.}}}$ Ans. (2).

(*e*) Net = (17784 ~ 684) lbs. = 17100 lbs. = $\underline{\underline{\text{7 tons 12 cwts. 2 qrs. 20 lbs.}}}$ Ans. (3).

Exercise 94.

(1.) Calculate the tare on 1 ton 5 cwts. 21 lbs. gross. Tare 18 lbs. per cwt.

(2.) Find the tare on 44 boxes, each containing 3 cwts. 3 qrs. 10 lbs.

(3.) Find the full allowance on 7 loads, weighing 1 ton 5 cwts. gross. Tare 4 lbs. per cwt. and tret 4 lbs. in 104.

(4.) Estimate the full allowance on 36 packages, each weighing 2 cwts. 2 qrs. 10 lbs. Tare 8 lbs. per cwt. and tret as usual.

(5.) Find the net weight of 6 loads, each 19 cwts. 1 qr. 3 lbs. gross. Tare 1 qr. 4 lbs. per cwt.

(6.) Find the net weight of 39 packages, each 3 cwts. 8 lbs. gross. Tare 18 lbs. per cwt.

(7.) Find the net weight of 3 casks, each 2 cwts. 20 lbs. Tare 1 qr. 1 lb. per cask.

(8.) Find the net weight of 27 barrels, each 6 cwts. 20 lbs. gross. Tare 50 lbs. per barrel.

(9.) Find the net weight of 7 tons 5 cwts. 24 lbs. Tare 8 lbs. per cwt. and usual tret.

(10.) Find the net weight of 5 tons 4 cwts. 1 qr. 4 lbs, gross, Tare 14 lbs. per cwt. and usual tret,

ALLIGATION.

Alligation is the rule which treats of the mixing togetl of articles of a similar kind but of dissimilar quality. Th are two cases, one simple the other more complex; both cas however, are easily solved by the rules given.

Rule XCV.

When the quantities and prices of the articles are given, find the price of the mixture.

1°. Multiply the price of each article by its quantity.

2°. Divide the sum of these products by the sum of t quantities. (The quantities must be of one and the same nomination.)

Illustrative Example.—A grocer mixes 30 lbs. of tea @ 2*s.* with 20 lbs. @ 3*s.* What must be the price per lb. of t mixture that he may gain 50 °/₀?

$$\left.\begin{array}{l} 30 \text{ lbs. @ } 2s.\ 6d = 75 \\ 20 \quad ,, \quad ,, \ 3s.\ 0d = 60 \end{array}\right\} \therefore 50 \text{ lbs.} = 135s. = \text{C.P.}$$

$$\text{By question 50 lbs. must} = (135 + 67\tfrac{1}{2})s. = 202\tfrac{1}{2}s.$$

$$\therefore 1 \text{ lb. must} = \underline{\underline{4s.\ 0\tfrac{3}{5}d.}} \quad \text{Ans.}$$

Rule XCVI.

When the price of each article is given, to find how mu of each must be taken to form a compound or mixture wo a given price.

1°. Write down in a vertical line all the given prices.

2°. To the left (or right) of these place the price of the quired mixture.

3°. Link all the prices together so that each pair shall co sist of one above and one below the outside price, and wri against each price the difference between the price to whi it is linked and the mean price. These differences and a equimultiples of them will give the required quantities.

Illustrative Example.—Having four sorts of sugar wo 1*d.*, 2*d.*, 3*d.*, and 4*d.* per lb., how much of each must be us to make a mixture worth 2½*d.* per lb.?

First Arrangement.

$$2\tfrac{1}{2}\left\{\begin{array}{l}\left\{\begin{array}{l}1\times\frac{1}{2}=\frac{1}{2}\\3\times1\frac{1}{2}=4\frac{1}{2}\end{array}\right.\\\left\{\begin{array}{l}2\times1\frac{1}{2}=3\\4\times\frac{1}{2}=\underline{2}\end{array}\right.\end{array}\right.\qquad 10$$

Second Arrangement.

$$2\tfrac{1}{2}\left\{\begin{array}{l}\left\{\begin{array}{lll}1\times1\frac{1}{2}=1\frac{1}{2}&\text{or}&3\\4\times1\frac{1}{2}=6&,,&12\end{array}\right.\\\left\{\begin{array}{lll}2\times\frac{1}{2}=1&,,&2\\3\times\frac{1}{2}=\underline{1\frac{1}{2}}&,,&3\end{array}\right.\end{array}\right.\qquad 10$$

Exercises 95 and 96.

(1.) A grocer buying and mixing 2 cwts. 1 qr. 18 lbs. of sugar @ £4, 7*s.* 6*d.* per cwt., with 4 cwts. 2 lbs. @ £1, 11*s.* 6*d.* per cwt., sells without gain or loss. Find selling price.

(2.) If 25 lbs. of coffee @ 1*s.* 1½*d.* per lb. be mixed with 200 lbs. @ 1*s.* 8¼*d.*, what is the value per lb. of the mixture?

(3.) If 47 lbs. @ 2*s.* 1¾*d.* per lb., 25 lbs. @ 2*s.* 4*d.*, and 20 lbs. @ 2*s.* 10¼*d.* per lb. be mixed, what is the price of the mixture?

(4.) Wheat is bought @ 48*s.* per quarter and also @ 39*s.* per quarter, in what proportion must the two be mixed to sell at 46*s.* per quarter?

(5.) Tea is bought @ 6*s.* and 4*s.* per lb. respectively, mix them so that by selling the mixture @ 5*s.* 3*d.* per lb. a gain may be realized of 16⅔ °/₀.

(6.) Mix liquids @ 1*s.*, 7*s.*, and 8*s.* per gallon with water so that the mixture may be worth 5*s.* per gallon.

(7.) Mix quantities @ 3*d.*, 2*s.* 3*d.*, 2*s.* 6*d.*, and 2*s.* 10½*d.* per lb. so that the mixture being sold at 2*s.* 10*d.* per lb. may realize a profit of 25 °/₀.

(8.) I mix two kinds of sugar @ 4*d.* and 6½*d.* per lb. In what proportions must they be mixed that by selling the compound @ 6*d.* per lb. I gain 20 °/₀?

(9.) Buying tea @ 3*s.* a lb. and also @ 2*s.*, how must I mix them that in selling @ 2*s.* 7½*d.* per lb. I gain 20 °/₀?

(10.) I buy at 4*s.* a lb. and also @ 5*s.* per lb., how must the qualities be mixed that by selling @ 4*s.* 8*d.* per lb. I may gain 12 °/₀?

(11.) How shall I mix tea @ 1*s.* 9*d.*, 2*s.*, 2*s.* 6*d.*, and 2*s.* 9*d.* a lb. that by taking 81 lbs. and selling @ 2*s.* 8*d.* per lb. I may gain £1, 7*s.*?

(12.) Potatoes are sold @ 3*s.* 3*d.*, 2*s.* 11*d.*, and 2*s.* 8*d.* per bushel, how many of each sort must be sold that the average price secured shall be 3*s.* a bushel?

POSITION.

In this rule assumed numbers are made use of, and by the employment of such numbers the real or required quantity sought in the question is obtained. Position is "*Single*" or "*Double*" according as the problem is simple or complex, or according to whether *one* or *two* assumed quantities are required in its solution. The rules in both cases require algebraical proofs, which of course cannot be furnished in a treatise on arithmetic, but any who are curious concerning them may obtain the necessary information in *Wood's Algebra*, and similar works.

In Single Position the required quantity is generally some multiple part or parts of another quantity which is given.

RULE XCVII.—FOR SINGLE POSITION.

1°. Assume any convenient number or quantity as the one required.

2°. Work with this assumed value as the question directs, and obtain an answer.

3°. Divide the true result, as given in the question, by the result obtained in 2°, and multiply the quotient by the assumed value in 1°.

Illustrative Example.—What number increased by the third, fourth, and fifth of itself will equal 107?

By 1° we assume 30 to be the number required,

then by 2° $30+\frac{30}{3}+\frac{30}{4}+\frac{30}{5}=53\frac{1}{2}$,

$$\therefore \text{ by } 3^\circ \ \frac{107\times30}{53\frac{1}{2}}=\frac{\cancel{107}\times30\times2}{\cancel{107}}=\underline{\underline{60}} \text{ required number.}$$

The student will perceive that this example could have been solved by a somewhat different method, which we will now exhibit. There is really no restriction laid upon a scholar as to the manner of working this and similar problems. In fact, when the present stage has been reached an apt and skilful calculator will as frequently as not employ his own peculiar devices, and become less and less dependent upon mere book rules. There can be nothing but applications—more or less complex—of preceding rules in all that may be proposed in what is generally known as Advanced Arithmetic.

We assume Unity then as our base of operations, and noting that 60 is the L.C.M. of 3, 4, and 5, the denominators of the fractions mentioned, we say—

$$\left(\frac{60}{60}+\frac{20}{60}+\frac{15}{60}+\frac{12}{60}\right)U=\frac{107}{60}\,U.$$

But by question $\frac{107}{60}\,U=107$

$\therefore\ U\ =60$ the required number.

Exercise 97.

(1.) In buying a property worth £5400 A pays twice as much as B, C three times as much as A, and D pays half the purchase money. Find each share.

(2.) A horse, gig, and harness cost £60; the harness cost half the price of the horse, and the horse and harness half the price of the gig. Find the price of each.

(3.) The third, the fourth, and the fifth parts of my quarterly income amount to £94, what salary do I draw every three months?

(4.) The half, the third, and the fourth parts of a number amount to 65, what is the number?

(5.) A sum of money amounts to £500 in 10 yrs. @ $6\,{}^{\circ}/_{\circ}$, what is that sum?

(6.) In a campaign $\frac{1}{5}$ of the men died in conflict, $\frac{1}{10}$ in sickness, and $\frac{1}{6}$ were taken prisoners. If 4000 were then remaining what was the original number?

(7.) From a barrel 10 gallons are drawn; one-fifth of the original contents leaks out and the barrel has then lost $\frac{1}{3}$. Find the original contents.

(8.) I lose $\frac{1}{6}$ and then $\frac{1}{10}$ of a certain sum; I then gain $\frac{1}{3}$ of same sum and find I have £3 more than at first. What was the original sum in my possession?

(9.) I add $\frac{1}{2}$, $\frac{1}{6}$, and $\frac{1}{24}$ of a certain number to itself and get 287. What is the number?

(10.) Give £100 to A, B, C, so that B may have £4 less than C and £3 more than A.

(11.) I multiply a number by 3, add 4, divide by 8, and get 32. What is the number?

(12.) What number is that of which if the half, the third, and the fourth be added together, the sum is 26?

(13.) I have a carriage worth £150 and 2 horses; one horse with the carriage is worth 3 times the other horse, but the 2nd horse and carriage are worth double the 1st horse. Find values of the two horses.

The rule of Double Position is more intricate, and it is only applied in those cases where the required quantity is not a multiple part or parts of the given quantity, but where the result depends upon incremental augmentation, two positions or quantities being assumed to find a solution to the question propounded.

Rule XCVIII.—For Double Position.

1°. Make two assumptions (say a_1 and a_2) for the required quantity and treat each of them separately as the question directs, noting the errors (e_1 and e_2).

2°. Divide the sum of the products $a_1 \times e_2$, and $a_2 \times e_1$, by the sum of the errors e_1 and e_2, and the quotient will be the number sought. If the errors in 1° are both too little or both too much, the *difference* in both products and errors must be taken instead of the sum.

Illustrative Example.—What number is that which being increased by 20 becomes six times as great as it was before?

First: suppose the number to be 10.........(a_1)
then $10 + 20 = 30$
but $6 \times 10 = 60$
∴ error = 30 (too much)............(e_1)

Second: suppose the number to be 8........(a_2)
then $8 + 20 = 28$
but $6 \times 8 = 48$
∴ error = 20 (too much)..........(e_2)

Consequently by rule—

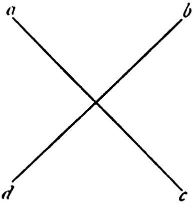
$$\frac{a_1 e_2 \sim a_2 e_1}{e_1 \sim e_2} = \frac{10 \times 20 \sim 8 \times 30}{30 \sim 20}$$

$$= \frac{40}{10} = \underline{\underline{4}}. \quad \text{Ans.}$$

It may be both interesting and profitable to give the rule for Double Position, as presented in one of the oldest works on arithmetic (published originally in the year A.D. 1677), "being that so long since promised to the world" and "composed (!) by Edward Cocker." The edition from which this rule is extracted was printed in 1751.

1°. When any question is stated in double position make such a cross as in the margin.

2°. Then make choice of any number you think may be convenient for your working, which call your first position and place it at the end of the cross at *a*; then work with this position, as if it were the true number sought, according to the nature of the question; then having found out your error, either too much or too little, place it on the side of the cross at *d*; then make choice of another number of the same denomination with the first position (which call your second position) and place it on the other side of the cross at *b*; then work with this position as with the former; and having found out your error, either too much or too little, place it on the side of the cross at *c*, and then the positions will stand at the top of the cross and the errors at the bottom, each under its corresponding position; and then multiply the errors into the positions cross-ways; that is to say, multiply the first position by the second error, and the second position by the first error, and put each product over its position.



3°. Having proceeded so far, then consider whether the errors are both alike; that is, whether they are both too much or both too little, and if they are alike then subtract the lesser product from the greater and set the remainder for a dividend; then subtract the lesser error from the greater and let the remainder be a divisor; then the quotient arising by this division is the answer to the question.

4°. But if the errors are unlike, that is, one too much and the other too little, then add the products of the positions and errors together and their sum shall be a dividend; then add the errors together and their sum shall be a divisor, and the quotient arising thence is the answer. Which two last rules may be kept in memory by the verse following, viz.:—

When errors are of unlike kinds,
  Addition doth ensue;
But if alike, Subtraction finds
  Dividing work for you.

Exercise 98.

(1.) A, B, and C have between them £780. The differen between C's share and the sum of A and B's is £82 mo than A's single share. But the difference between A share and the sum of the other two shares is £43 le than C's share alone. What is each person's share the £780?

(2.) I wished to divide £100 amongst 3 persons, giving t first £3 more than the second, and the third £4 mo than the first. What did I give to each?

(3.) A lady wished to give 3*d.* each to a number of orpha but found she had 10*d.* too little; she then gave the 2*d.* each and had 4*d.* left. What was the number orphans?

(4.) A's age is 9 years, B's age is equal to A's and half C while C's age is equal to A's and B's together. Ho old are B and C?

(5.) There is a certain number that being multiplied by 3, t result increased by 4, and the sum divided by 16, t quotient is 16. Find the number.

(6.) A pole is 10 ft. out of the water, $\frac{1}{4}$ of its length in t water, and $\frac{1}{3}$ in the earth. What is its entire length

(7.) Three partners contribute £1000. A pays a certa amount, B £100 more, and C as much as both the othe together. What did each contribute?

(8.) I wish to distribute some money amongst a number people. If I give 5*s.* to each I shall require 1 additional; so I give only 4*s.* each and I have then left. How much did I dispense and to how ma persons?

(9.) I have spirits at 9*s.* and 13*s.* per gallon, and I made mixture of 100 gallons worth 12*s.* per gallon. Wh quantity of each sort did I use for the compound?

(10.) A fish with a head 9 inches long, has its tail as long its head and half its body, and its body is as long as t head and tail together. What is the full length of t fish?

ANNUITIES.

An Annuity is a certain amount or sum which a person receives every year, and which is payable in one sum or by half-yearly or quarterly instalments. Annuities are "Certain" (for a determined number of years); "Contingent" or "Life" (continuing during the lives of one or more persons); and "Perpetual" (for ever)—called **Perpetuities.** Many interesting problems arise connected with Annuities which require considerable care in the solution. The following rules will solve most of the general questions on this subject, but the subject can only receive satisfactory and exhaustive treatment in works on algebra or in cyclopædias.

RULE XCIX.

To find the amount of a certain annuity left unpaid for any number of years, allowing simple interest on each sum from the time it becomes due.

1°. Multiply the interest of £1 for 1 year at the given rate by the number of years less 1, and add 2 to the product.

2°. Multiply the sum thus obtained by half the product of the annuity into the number of years.

RULE C.

To find the amount of an annuity which is left unpaid, for any number of years at compound interest.

1°. Find the amount of £1 for 1 year at the given rate, raise this to the power indicated by the number of years, and reject one from the result.

2°. Divide the quantity last obtained by the interest of £1 for 1 year at the given rate, and multiply the quotient by the amount of the annuity.

RULE CI.

To find the present value of a perpetual annuity.

1°. Divide the amount of the annuity by the interest of £1 or 1 year at the given rate.

Illustrative Examples.—1. What will be the amo
£1212 per annum left unpaid for 76 years, reckoning 4
annum compound interest?

$$1\cdot04 = \text{amount of £1 for 1 year at the given rate}$$
$$\log 1\cdot04 = \cdot0170333. \quad \text{(See Rules CXII. and C}$$
$$76 \times \cdot0170333 = 1\cdot2945333.$$

The number answering to

$$1\cdot2945333 = 19\cdot70304$$

we reject one and get

$$18\cdot70304$$

and $18\cdot70304 \div \cdot04 = 467\cdot576.$

Lastly $467\cdot576 \times 1212 = £566702,\ 2s.\ 3d.$

which amount is as near as the 7 figure logarithms all
correct answer being £566702, 14*s.* 4*d.* nearly.

2. What is the present value of a perpetual annuity o
a year, interest being at 3 °/o?

$$\text{By rule present value} = £\frac{102}{\cdot03}$$
$$= £\frac{10200}{3}$$
$$= £3400 \quad \text{Ans.}$$

Exercises 99-101.

(1.) What will an annuity of £127 a year amount tc
years @ 5 °/o compound interest?

(2.) Find the amount of an unpaid annuity of £27, 6*s.*
40 years @ 4 °/o compound interest.

(3.) What is the value of an unpaid annuity of £93 for
@ 3½ °/o compound interest?

(4.) What is the present value of an annuity of £100
years @ 4 °/o?

(5.) Find the value of a perpetual annuity of £84
@ 3 °/o.

(6.) What is the present value of an annuity of £170
years @ 3 °/o?

(7.) What is the present worth of an annuity of £450, commencing 10 years hence and continuing for 40 years @ 4 °/₀?

(8.) An annuity of £350 was left to a younger daughter for 5 years, and afterwards in perpetuity to another daughter, what was actual value of both legacies on the day that the younger daughter came into possession, money being charged @ 4 °/₀?

(9.) An estate is bought @ 18 years' purchase for £9819, what should be the annual rent?

(10.) How much must I give for a freehold yielding £100 a year so as to secure to myself 5 °/₀ for my outlay?

SQUARE ROOT.

The Square Root of any number is that number which when multiplied by itself equals the given number. The rule for the extraction of the square root of any number is a very simple one, but the proof is attended with some difficulty, and should be studied in connection with algebra.

Rule CII.

To extract the square root of any given number, such number being an abstract integral quantity, or a simple decimal.

1°. Point the number off into periods of two figures each, beginning at the unit figure or at the decimal point.

2°. Find the root of the first left-hand period or the root of the nearest square number less than that period; place this square number under the first period and find the difference by incremental addition, bringing down the next right-hand period.

3°. Bring down twice the root figure to the left of the last result as the trial divisor, find the new root figure by division (ignoring the unit figure of the dividend) and place it both in the root and to the right of the trial divisor, forming thus the real divisor.

4°. Multiply the full divisor now obtained by the new root figure, place the product under the result obtained by 2°, and add incrementally, bringing down the next period as before.

N.B.—The above method may be contracted in very l and tedious questions. When one more than half the num of root figures have been taken we may cut off the last rig hand figure of the divisor at each subsequent division, proce ing according to the rule for contracted division of decin for the remaining figures of the root. This method should be resorted to if absolute accuracy be required in both r and remainder.

Illustrative Example.—Find the square root of 69039481

Root.	
8309	69'03'94'81
163	503
16609	149481
	......

Here we first mark off into periods of two figures ea beginning at the unit figure 1. Then taking 8, the root of nearest square number 64 under or less than the 69 of the fi left-hand period, we add the 64 incrementally to the 69 a bring down the next period 03, the root figure 8 being pla in its own position. Doubling 8 we get 16 or the trial divis It will go three times in 50 (ignoring the unit figure 3). place 3 in root and also to right of 16, thus making the r divisor. Multiplying this true divisor by the new root figur and adding incrementally, we obtain 14 as difference and bri down the next period 94. Doubling the root we have 1 which is not contained in 149 (ignoring the unit figure 4), therefore place a cipher in root and trial divisor and bri down last period 81. 9 is the new root figure, which we pl in root and also in true divisor, and on multiplying there is difference or increment to bring down, and the work is th complete.

Should the quantity given involve fractions the followi directions will satisfy all requirements:—

1. Reduce to lowest terms (if a simple fraction and ter not perfect squares) and extract roots of both terms se rately; or

2. If either or neither of the terms be a perfect squa then—

(*a*) Find the root of the product of the terms and div it by the denominator.

(*b*) Reduce the fraction to a decimal and extract the square root.

(*c*) If the denominator be a perfect square and the numerator not, divide the root of the numerator (to any required number of places) by root of denominator.

(*d*) If the numerator be a perfect square and the denominator not, divide the product of the square roots of both terms by the denominator.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Square...	1	4	9	16	25	36	49	64	81	100	121	144	169	196	225	256	289	324	361
Cube.....	1	8	27	64	125	216	343	512	729	1000	1331	1728	2197	2744	3375	4096	4913	5832	6859

It will be very advantageous to the student to have the above table of Squares and Cubes perfectly familiar to his mind, as it will save much useless labour in many of his subsequent computations.

Exercise 102.

Find the square root of the following quantities:—

(1.) 1079521.
(2.) 1032256.
(3.) 47089.
(4.) 2298243600.
(5.) 574560900.
(6.) 998001.
(7.) 8538084.
(8.) 11854249.
(9.) 1522756.
(10.) 22099401.
(11.) 893830609.
(12.) 50836900.
(13.) 870014016.
(14.) 61013446081.
(15.) 49196196.
(16.) 502681.

Find the square root of the following quantities:—

(17.) 2253001.
(18.) 961310025.
(19.) 10009002025.
(20.) 106·1031844096.
(21.) 81006480·1296.
(22.) 168141·57657049.
(23.) 3712988672752804.
(24.) 38613858140025.
(25.) 62774055768064.
(26.) ·4 to 6 places.
(27.) ·005 to 5 places.
(28.) $210\frac{1}{4} : 9\frac{67}{121} : 1{\cdot}\dot{7} : 3$.
(29.) $27\frac{54}{361} : 258{\cdot}16561 : 25{\cdot}439$.
(30.) $35{\cdot}672 : {\cdot}\dot{4} : 576{\cdot}4801$.
(31.) 121022001.
(32.) 441924484.
(33.) 935992836.
(34.) 1936352016.
(35.) 2948707204.
(36.) 15140072025.
(37.) 3661097049.
(38.) 641448819025.
(39.) 829740631801.
(40.) 367315996356.
(41.) 82460501842952
(42.) 98184473800926
(43.) 49985039844697
(44.) 12370340624653
(45.) 82447671313860

The following rules are here inserted as affordin agreeable and profitable variation on the ordinary special cases of finding the second powers of numbers.

Rule CIII.

To square a two-digit number with unit figure 5.

1°. Multiply the tens digit into the next higher and annex 25 to the product.

Illustrative Examples.

$$(75)^2 = (7 \times 8)100 + 25 = 5625.$$
$$(95)^2 = (9 \times 10)100 + 25 = 9025.$$

Exercise 103.

Square the following numbers by the contracted given in Rule CIII.:—

(1.) 15.
(2.) 25.
(3.) 35.
(4.) 45.
(5.) 55.
(6.) 65.
(7.) 75.
(8.) 85.
(9.)

Rule CIV.

To square a tridigit number whose two last figures

1°. Square the hundreds figure, add to it one half th *dreds* figure and annex 0625.

Note.—If the hundreds figure be odd take half the next less figure and annex 5625.

Illustrative Examples.

$(425)^2 = 4^2 +$ half 4 with 0625 annexed $= 180625$.

$(725)^2 = 7^2 +$ half $\underline{\underline{6}}$ with 5625 annexed $= 525625$.

Exercise 104.

Square the following numbers:—

(1.) 125.
(2.) 225.
(3.) 325.
(4.) 425.
(5.) 525.
(6.) 625.
(7.) 725.
(8.) 825.
(9.) 925.

Rule CV.

To square a tridigit whose unit figure is 5 and tens figure 7.

1°. Multiply the hundreds figure into the next higher, add half the hundreds, and affix 5625. If the hundreds be odd add half the next higher digit and annex 0625.

Illustrative Examples.

$$(475)^2 = (4 \times 5 + 2)10000 + 5625 = 225625.$$

$$(775)^2 = (7 \times 8 + \underline{\underline{4}})10000 + 0625 = 600625.$$

Exercise 105.

Square the following numbers:—

(1.) 175.
(2.) 275.
(3.) 375.
(4.) 475.
(5.) 575.
(6.) 675.
(7.) 775.
(8.) 875.
(9.) 975.

Rule CVI.

To square any number which is composed of any number (less than 10) of the same digit or figure.

1°. Multiply the square of the same number of units (which can be written down) by the square of the digit in the given number.

Illustrative Examples.—1. **Find the square of 444.**

First the square of 111 is 12321
∴ square required = 16 × 12321 = 197136

2. Find the square of 5555555.

First the square of 1111111 is 1234567654321
and 1234567654321 × 25 = 30864191358025.

Note.—The square of the double of any number is f times the square of that number.

Exercise 106.

Square the following numbers:—

(1.) 111, 222, 333.
(2.) 1111, 2222, 3333.
(3.) 11111, 22222, 33333.
(4.) 444, 555, 666.
(5.) 4444, 5555, 6666.
(6.) 777, 888, 999.
(7.) 7777, 8888, 9999.
(8.) 77777, 88888, 9999
(9.) 11111111, 22222222
(10.) 33333333, 44444444
(11.) 55555555, 66666666
(12.) 77777777, 88888888
999999999.

CUBE ROOT.

The cube root of any given number is that number wh when raised to the third power is equal to the given numb Thus the cube or third root of 64 is 4, because 4 raised to third power, or cubed, is equal to 64, the given number.

RULE CVII.

To extract the third or cube root of any abstract integral decimal number.

1°. Divide the given number into periods of three figu each, beginning at the unit figure, or if a decimal at decimal point.

2°. Find the nearest cube number under the first or le hand period, add it incrementally to the first period, a annex the next right-hand period to the difference or inc *ment* so found, placing the root figure in the root or answe

3°. For the trial divisor multiply the square of the root figure by 300 and put it down to the left of the result obtained in 2°, and by division ascertain the next figure in the answer, which place in the root. (If this figure be cipher then place 2 ciphers to the right of the trial divisor and bring down another period of 3 figures to the right of the temporary dividend.)

4°. To the trial divisor add thirty times the product of the new root figure and the preceding part of the root and also the square of the new root figure. This sum forms the true divisor, which must be multiplied by the new root figure and added incrementally to the last dividend. Then bring down the next period.

5°. The trial divisor is obtained as before or it may be calculated as follows: bracket the *last* 3 lines in the trial divisor together, take their sum, being careful to double the middle line of the 3, annex 2 ciphers, and proceed with this trial divisor as already directed.

Note (*a*).—If the number be fractional reduce to the decimal form (unless the terms be perfect cubes), and extract the cube root.

Note (*b*).—The cube of the double of any number is eight times the cube of that number.

Illustrative Example.—Find the cube root of 167284·151.

$$\begin{array}{r|l}
\text{Root}\quad 55{\cdot}1 & 167'284'{\cdot}151' \\ \hline
5^2\times 300 = 7500 & 42284 \\
5\times 5\times 30 = 750 & \\
5^2 = 25\ \Big\}\times & \\
8275 & (41375)^* \\ \hline
907500 & 909151 \\
55\times 1\times 30 = 1650 & \\
1^2 = 1 & \\
909151 & (909151)^*
\end{array}$$

[*] This line is not essential, but it may be helpful to the beginner. After pointing off according to rule we find 125 to be the nearest cube number under 167, we therefore put 5 in the root and add incrementally 125 to 167 bringing down the next period 284. Then squaring 5 and multiplying it by 300 we get 7500 (the trial divisor). Operating we find 5 to be the new root figure; the product of 5 and 5 and 30 gives 750, and 5 squared gives 25, both of which we add to the trial divisor and the result is 8275 (the real divisor): multiplying, adding incrementally, and bringing down we obtain 909151.

To get the new trial divisor we bracket the 3 last lines of preceding divisional section and add them, taking care to double the middle line (25). Affixing 2 ciphers, making the number 907500, we proceed with this as with the former trial divisor.

Exercise 107.

Extract the Cube Root of the following quantities:—

(1.) 2924207.
(2.) 8120601.
(3.) 1860867.
(4.) 66430125.
(5.) 223648543.
(6.) 529475129.
(7.) 1070599167.
(8.) 8414975304.
(9.) 28233316125.
(10.) 157989463416.
(11.) 275513205843.
(12.) 344177344512.
(13.) 513729944729.
(14.) 756307034631.
(15.) 10546683057.
(16.) $2\frac{1371}{2744}$.
(17.) 589365742·983688.
(18.) 2326203·125.
(19.) 84·9.
(20.) 731189·187729.
(21.) 352045367·981.
(22.) $35\frac{162}{343}$.
(23.) 5·78 to 3 decimal places.
(24.) 11 to 4 places of decimals.
(25.) 40·353607.
(26.) $47307\frac{1}{216}$.
(27.) $47558\frac{2185}{2197}$.
(28.) ·25 to 3 places.
(29.) ·000946966168.
(30.) ·00000051478848.
(31.) 1953125.
(32.) 334255384.
(33.) 374805361.
(34.) 341532099.
(35.) 627222016.
(36.) 29218112.
(37.) 502459875.
(38.) 647214625.
(39.) 51478848.
(40.) 997002999.
(41.) 1879080904.
(42.) 95256152263.
(43.) 354744554039.
(44.) 706633718643.
(45.) 185485563927.
(46.) 963259373376.
(47.) 672221376.
(48.) 447697125.
(49.) 216973458729.
(50.) 51853389489.

PROGRESSIONS.

Questions in Progressions occur but seldom in arith The full and scientific discussion of the subject is to be in works on algebra. However, as problems requi knowledge of the principles involved are sometimes pr in examination papers, the subject shall here receive a consideration.

When a series of numbers increases or decreases by a common and unvarying difference, it forms what is called an Arithmetical Progression. When the series increases or decreases by a common ratio it is said to be in Geometrical Progression. Thus 2, 4, 6, 8, are in Arithmetical Progression (A. P.), whilst 2, 4, 8, 16, are in Geometrical Progression (G. P.).

RULE CVIII.

Given the first and last terms (a and l) of an Arithmetical Progression, also the number of terms (n), to find the common difference (d), and thus to insert all the means.

1°. Divide the difference of the first and last terms by the number of terms less one, or $d = \frac{l \sim a}{n \sim 1}$.

Illustrative Example.—Given the first term 3 and the last term 43 of a series of 11 terms to find the common difference and to insert all the means.

$43 \sim 3 = 40$ and $40 \div (11 \sim 1) = 40 \div 10 = 4 =$ com. difference,

$\therefore$ terms are 3, 7, 11, 15, 19, 23, 27, 31, 35, 39, 43.

RULE CIX.

To find the sum of a series in A. P.

1°. Multiply half the sum of the first and last terms by the number of terms, or $s = \frac{n}{2}(a + l)$.

Illustrative Example.—Find the sum of a series of 11 terms in A. P., the first term being 3 and the last 43.

Here $3 + 43 = 46$ and half $46 = 23$

then $11 \times 23 = \underline{\underline{253}}$. Ans.

The following equation is very useful, as from it any one of the given quantities may be found when the other three are given:—

$$s = \frac{n}{2}\{2a + (n \sim 1)d\}.$$

Note.—If the number of terms in an Arithmetical Progression be odd, the middle term is equal to half the sum of the first and last terms.

Exercises 108, 109.

(1.) Sum the following series to 20 terms each:—

(*a*) 1, 6, 11, 16 + &c.
(*b*) 5, 8, 11, 14 + &c.
(*c*) 100, 110, 120 + &c.
(*d*) $\frac{1}{2}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$ + &c.
(*e*) $\frac{1}{3}$, $\frac{2}{3}$, 1, $1\frac{1}{3}$ + &c.
(*f*) 3, 5, 7, 9 + &c.
(*g*) 25, 24, 23 + &c.

(2.) (*a*) Find sum of the series of which 3 is the first a
the fiftieth.
(*b*) Sum the series 1, 2, 3, 4, up to 100.

(3.) Sum the following series:—

(*a*) 5, $4\frac{3}{4}$, $4\frac{1}{2}$, $4\frac{1}{4}$ + &c., to 21 terms.
(*b*) $2\frac{1}{2}$, $2\frac{5}{6}$, $3\frac{1}{6}$, &c., to 13 terms.
(*c*) $2\frac{1}{3}$, $3\frac{5}{24}$, $4\frac{1}{12}$, &c., to 24 terms.

(4.) Find the twentieth term in each of the following se

(*a*) 1, 6, 11, &c.; (*b*) $\frac{1}{3}$, $\frac{2}{3}$, 1, &c.; (*c*) $\frac{1}{2}$, $\frac{3}{2}$, $\frac{5}{2}$, &c.

(5.) Insert 40 arithmetical means between 0 and 20.
(6.) „ 15 „ „ „ 3 and 47.
(7.) Find the series in A. P. with 3 as first and 17
twenty-ninth term.

In Geometrical Progression the common multipl
which any term is derived from the preceding, is call
common ratio. If the two extremes and the number of
in a Geometrical Series be given the means may be fou

Rule CX.

Given the extremes and number of terms in a G. P.
the means.

1°. Divide the last term by the first.

2°. Extract that root of the quotient just found wl
indicated by the number of terms less one. This giv
ratio.

3°. Use this ratio by multiplication to obtain all the

Illustrative Example.—There are five means between 5 and 3645 in G. P.: find them.

First $3645 \div 5 = 729$

There are 7 terms in the series $\therefore$ we must find the 6th root of 729: we find this to be 3,

$\therefore$ the means are (5), 15, 45, 135, 405, 1215, (3645). Ans.

Rule CXI.

To find the sum of a series in G. P.

1°. To the product of the last term and the common ratio add the first term incrementally.

2°. Divide the result by the common ratio less one, or $s = \dfrac{rl \sim a}{r \sim 1}$.

Illustrative Example.—Find the sum of a series in G. P. the first term being 5, the last 3645, and the ratio 3.

$$3 \times 3645 \sim 5 = 10930$$
$$\text{and } 10930 \div 2 = 5465. \text{ Ans.}$$

From the above equation $\left(s = \dfrac{rl \sim a}{r \sim 1}\right)$ any quantity may be found when the other 3 are given.

Where the series is infinite the following form is used when the ratio is a proper fraction $s = \dfrac{a}{1 \sim r}$.

Exercises 110, 111.

(1.) Insert a geometrical mean between $7\frac{1}{2}$ and 30, and between $\frac{1}{3}$ and $\frac{3}{4}$.

(2.) Find 2 geometrical means between 320 and 5, and between $\frac{1}{8}$ and 1.

(3.) There are 3 geometrical means between 6 and 486: find them.

(4.) Place 3 geometrical means between $2\frac{14}{25}$ and 100.

(5.) Find the sum of the G. P. $5 + \frac{15}{7} + \frac{45}{49}$, &c., to infinity.

(6.) " ". " $\frac{5}{3} + 1 + \frac{3}{5}$ " "

(7.) " " " $\frac{2}{3} - \frac{1}{2} + \frac{3}{8}$ " "

(8.) Insert 7 geometrical means between 2 and 13122.

(9.) Find the sum of a series of 12 terms, $\frac{1}{4}$, $\frac{1}{2}$, 1, 2, &c.

(10.) What would a man's wages come to in a year if he took 1*s.* the first month and doubled the amount each month?

LOGARITHMS.

Logarithms are a series of numbers adapted in a way to a series of ordinary numbers to facilitate nu calculations. In the expressions $10^1 = 10$, $10^2 = 100$, 10 the index 1 is said to be the logarithm (hence called lo to the base 10, 2 is said to be the log of 100 to base 1 log of 1000 to base 10; or, in other words, log 10 = 1, = 2, log 1000 = 3. The logarithm of any number, th to a given base is that power to which the base must b to give the number.

The integral part of the logarithm of a number i the Index or Characteristic, the decimal part is cal Mantissa.

The Characteristic is always one less than the nu integral figures which the number contains. When th ber has *no* integral figures the index is negative, anc more than the number of ciphers immediately after the point. These indices must be supplied by the calcul they are not given in the Logarithmic Tables.

Much practice will be necessary before the scholar to make a satisfactory and profitable use of the tabl subject should therefore be taken in hand with great mination and energy. Only a few of the most usefu can now be presented, comprising those necessary for tl nary arithmetical calculations.

RULE CXII.

To find the logarithm of a given number from the ta

1°. The first four figures (or less, if there be less) given number may be looked for in the first column left, the fifth figure in the top line and opposite to t four, and under the fifth (if there be a fifth) will be fou logarithm. For the sixth figure, multiply the tabular dil by it, cut off the right-hand digit from the product a the other figures to the logarithm already found. Sho *number* be composed of seven figures, multiply the difference by the number made up of the sixth and seventh figures, reject two right-hand figures and add the rest as before.

Illustrative Example.—Find the logarithm of 834079.

We first find 8340 in the left-hand column of the tables; then finding 7 in the top line we run our eye down till we reach the logarithm opposite 8340, which logarithm we find to be ·9212025. The tabular difference 52 we multiply by the 9 (or sixth figure of our number) obtaining 468. Cutting off the right-hand figure 8 we have 46, which added to ·9212025 gives us ·9212025 + 46 = ·9212071, or ·9212072 if we take 47 instead of 46. Prefixing the index 5 the full answer is 5·9212072.

Exercise 112.

Find the logarithms of the following numbers:—

(1.) 351.
(2.) 450.
(3.) 5071.
(4.) 3298.
(5.) 67543.
(6.) 89765.
(7.) 40031.
(8.) 21050.
(9.) 86417.
(10.) 29308.
(11.) 123456.
(12.) 234567.
(13.) 304050.
(14.) 607080.
(15.) 901023.
(16.) 9876543.
(17.) 9080706.
(18.) 5040030.
(19.) 2198765.
(20.) 9998887.

RULE CXIII.

To find the number corresponding to a certain logarithm.

1°. When the logarithm is found exactly in the tables the first four figures of the required number will be seen in the left-hand column and opposite to the given logarithm, the fifth figure being at the top of the column in which the logarithm is found. The index of the logarithm increased by 1 will be the number of integers in the number sought, or the index diminished by 1 will be the number of prefixed ciphers in the decimal fraction when the index is negative.

Illustrative Example.—Find the number corresponding to the logarithm 4·8773080.

Referring to the tables we find in the left-hand column opposite 8773080 the number 7538, and at the top of the column we get the fifth figure 9. The required number is then 75389 as an integer, since the index 4 of the logarithm requires five integral figures in the number.

Note.—If the logarithm be not found exactly in the tables, find the logarithm next lower than the given one and write down the first five figures of the number as before. Take the difference between this logarithm and the given one, add a cipher to it, and divide by the tabular difference; the quotient will give the sixth figure; add another cipher and the next quotient figure will be the seventh figure of the required number.

Exercise 113.

Find the numbers corresponding to the following logarithms:—

(1.) 2·1760913.
(2.) 2·2966652.
(3.) 3·3909351.
(4.) 1·4899585.
(5.) 2·5622929.
(6.) 3·6159501.
(7.) 1·7058637.
(8.) 2·8000294.
(9.) 3·9003671.
(10.) 2·9956352.
(11.) 1·0778038.
(12.) 2·1509712.
(13.) 3·2205003.
(14.) 4·3000082.
(15.) 1·4000023.
(16.) ·5116026.
(17.) $\bar{1}$·6360699.
(18.) $\bar{2}$·7350077.
(19.) $\bar{3}$·8000018.
(20.) $\bar{4}$·9000010.

RULE CXIV.

To perform Multiplication and Division by the aid of logarithms.

1°. To multiply—add the logarithms of the numbers, and the number answering to the sum (which is the logarithm of the product of the numbers) will be the product sought.

2^{c}. To divide—add the logarithms incrementally, and the number answering to the difference (which is the logarithm of the quotient) will be the answer required.

Illustrative Examples.—1. Multiply 4567 by 78.

Here log 4567 = 3·6596310
and „ 78 = 1·8920946
5·5517256

The number answering to 5·5517256 is 356226, which is the *product* sought.

2. Divide 2147421 by 87.

$$\begin{array}{lr} \text{Here log } 2147421 = & 6{\cdot}3319171 \\ \text{and log } \quad 87 = & \underline{1{\cdot}9395193} \\ & 4{\cdot}3923978 \end{array}$$

And the number answering to 4·3923978 is found to be 24683, which is the required quotient.

Exercise 114.

Perform the operations indicated, by means of logarithms, correct to seven figures:—

(1.) 510×316.
(2.) 248×128.
(3.) 563×742.
(4.) 891×206.
(5.) 375×78.
(6.) 91324×6.
(7.) 52716×8.
(8.) $1398765 \div 15$.
(9.) $94721 \div 11$.
(10.) $36214 \div 513$.
(11.) $436 \times 214 \div 218$.
(12.) $(57 \times 8) \div (9 \times 27)$.
(13.) $(86 \times 37) \div (43 \times 74)$.
(14.) $(981 \times 54) \div (72 \times 909)$.
(15.) $654321 \div 87654$.

RULE CXV.

To perform Involution and Evolution by the aid of logarithms.

1°. Multiply the logarithm of the given number by the exponent of the power to which it is to be raised, and the product will be the logarithm of the required power.

2°. Divide the logarithm of the given quantity by the index of the root which is to be extracted, and the quotient will be the logarithm of the required root.

Illustrative Examples.—1. Raise 107 to the third power by logarithms.

$$\begin{array}{lr} \text{Log } 107 = & 2{\cdot}0293838 \\ & \underline{3} \\ & \underline{\underline{6{\cdot}0881514}} \end{array}$$

The number answering to 6·0881514 is 1225043, therefore the required power is 1225043.

2. Find the fourth root of 531441.

Log 531441 = 5·7254550.

$$4\,\underline{)\,5{\cdot}7254550}$$
$$\;\;1{\cdot}4313637 \text{ (or 8).}$$

Now the number corresponding to 1·4313637 is 27 exactl therefore 27 is the required root.

Exercise 115.

Find the powers and roots indicated, by logarithms corr to seven figures:—

(1.) $(123)^3$.
(2.) $(304)^2$.
(3.) $(14{\cdot}41)^2$.
(4.) $(98)^3$.
(5.) $(4{\cdot}7)^4$.
(6.) $(5001)^2$.
(7.) $\sqrt[2]{203405.}$
(8.) $\sqrt[2]{456217.}$
(9.) $\sqrt[3]{863219.}$
(10.) $\sqrt[3]{576237.}$
(11.) $\sqrt[4]{847209.}$
(12.) $\sqrt[5]{123456.}$

COMPOUND INTEREST.

Compound Interest differs from Simple Interest in t that the interest accruing year by year is not paid over the lender, but is added to the principal and retained by borrower, who thus pays interest on a constantly increasi capital. Four modes of calculating Compound Interest w be exhibited, the third of which is the only one employed business. The exercises in this rule should be worked out each of the methods if Interest Tables are available.

Rule CXVI.

To find the compound interest of any given principal for given number of years at a given rate °/ₒ.

A. 1°. Find the interest on the given principal at the giv rate for *one* year, or period, and add this interest to the pri *cipal.*

2°. Calculate the interest on this augmented principal at the same rate for the second (one single) year (or period), and add the interest thus obtained to the principal last operated on.

3°. Proceed in like manner with the principal for the third year or period, and all following years or periods, and the difference between the last amount and the original principal will be the compound interest required.

B. 1°. Take or find the amount of £1 for a year at the given rate and raise it to the power indicated by the number of payments.

2°. Multiply this amount by the number of pounds in the given principal, using decimals, fractions, or aliquot parts, where shillings and pence are involved. The product is the amount from which the required interest may be obtained, as in case (a).

C. 1°. Obtain from the tables the amount of £1 for given time and at the given rate.

2°. Multiply this amount by the principal for the answer.

D. By logarithms,

$$\text{Log } a = \log p + t \log R.$$

where a = amount.
p = principal.
t = time or number of payments.
$R = (1 + r)$ = amount of £1 for one period.

Illustrative Example. — Find the compound interest and amount on £2000 for four years @ 5 $^\circ/_\circ$.

First by method A.

£2000	P_1.
100	$I_1 = (\frac{1}{20}$ of 2000 or 5 $^\circ/_\circ$).
2100	P_2 or A_1.
105	I_2.
2205	P_3 or A_2.
110·25	I_3.
2315·25	P_4 or A_3.
115·7625	I_4.
2431·0125	A_4 = amount required.

∴ Compound interest required = £431·0125.

Second by method B.

1·05 = amount of £1 for one year.
1·05
525
105
1·1025
105
55125
11025
1·157625
105
5788125
1157625
1·21550625 = 4th power.

1·21550625
2000
2431·01250000

∴ Compound interest required = £431·
and amount required = £2431·012

Thirdly by method C.

The only variation in this method is that the 4th p
1·21550625, or the amount of £1 for given time at given
is obtained direct from interest tables. The rest of the
is identical with method B.

Fourthly by method D, or logarithms.

$$\begin{aligned} \text{Log } a &= \log p + t \log \text{R}. \\ \text{Log } p &= \log 2000 = 3{\cdot}3010300 \\ t \log \text{R} &= {\cdot}0847572 \\ \therefore \log a &= 3{\cdot}3857872 \end{aligned}$$

and the number answering to this log is 2431·012.

∴ required amount = £2431·012.

Exercise 116.

		£	s.	d.				
(1.)	Find the compound interest of	112	10	0	for	3	years	@ 3
(2.)	” ” ”	104	0	0	”	$1\frac{3}{4}$	”	” 5
(3.)	” ” ”	4800	0	0	”	2	”	” 4
(4.)	” ” ”	1000	0	0	”	3	”	” 4
(5.)	” ” ”	2000	0	0	”	4	”	” 3
(6.)	” ” ”	1200	0	0	”	4	”	” 5

		£	s.	d.				
(7.)	Find the compound interest of	1272	0	0	for	3	years @	4¾ °/ₒ.
(8.)	,, ,, ,,	1000	0	0	,,	2	,, ,,	2½ ,,
(9.)	,, ,, ,,	512	0	0	,,	3	,, ,,	6¼ ,,
(10.)	,, ,, ,,	2500	0	0	,,	3	,, ,,	4½ ,,
(11.)	,, ,, ,,	4000	0	0	,,	4	,, ,,	3½ ,,
(12.)	,, ,, ,,	725	0	0	,,	4	,, ,,	5 ,,
(13.)	,, ,, ,,	260	10	0	,,	3	,, ,,	5½ ,,
(14.)	,, ,, ,,	125	0	0	,,	3	,, ,,	2½ ,,
(15.)	,, ,, ,,	87	10	0	,,	3	,, ,,	4 ,,

(16.) Find the difference between simple and compound interest on £383, 5*s*. 8*d*. for 2½ years @ 3¾ °/ₒ.

SCALES OF NOTATION.

In the Common Notation ten (10) is the radix or root of the scale, but any other number may form the radix or base of a scale. Thus we have the binary with 2 as radix; ternary with 3 as radix; denary or decimal with 10 as radix; duodenary or duodecimal with 12 as radix, and so on. In any scale of Notation every digit is necessarily less than the radix (or R), and the number of them including 0 is equal to R. The most valuable scale of Notation after the denary is the duodenary, which has 12 for its radix, but two new signs are required to express ten and eleven. They may, of course, be any symbol distinct from the other digits, but t and e are generally used for this purpose. The theory of Notation Scales may be studied in any good Algebra, the discussion of it in this work would be out of place, as the subject has nothing whatever to do with ordinary practical arithmetic.

Rule CXVII.

To express a given whole number in any required or proposed scale.

1°. Divide the given number by the proposed radix and the remainder is the first or unit figure of the new scale.

2°. Again perform the division and the remainder will be the second of the required digits. Repeat the division as far as possible and the last quotient with the several remainders will form the number in the new scale.

Illustrative Examples.

1. Express 1820 (in the denary) in a scale with radix 6.
2. Transform 12232 from a scale with R 6 to a scale with R 4

(1.)

$$\begin{array}{r|r}
6 & 1820 \\ \hline
6 & 303-2 \\ \hline
6 & 50-3 \\ \hline
6 & 8-2 \\ \hline
 & 1-2
\end{array}$$

∴ Required number 12232.

(2.)

$$\begin{array}{r|r}
4 & 12232 \\ \hline
4 & 2035-0 \\ \hline
4 & 305-3 \\ \hline
4 & 44-1 \\ \hline
4 & 11-0 \\ \hline
 & 1-3
\end{array}$$

∴ Required number is 130130

Exercise 117.

(1.) Express 32567325 in the duodenary scale.

(2.) Express 20736531 in the duodenary scale.

(3.) Transform 6520115 from the septenary to the undenar scale.

(4.) Transform 101101101101 from the septenary to the decim scale.

(5.) Having given 24563 and 236 in the septenary scale, multiply them together and transform the result to th duodecimal scale.

(6.) Multiply 1 t e 7 by 2 t 6 in the duodenary scale, and prove the answer by reducing the multiplicand, multiplier, and product to the denary scale.

(7.) Transform 17400 from the denary to the duodenary scale, and find the square of it in the duodenary scale.

(8.) Reduce the denary numbers 7384 and $51{\cdot}2\dot{7}$ to the duodenary scale and divide the former by the latter in that scale.

(9.) Extract the square root of 105404·440241 in the scale of 6 and express the result in the duodenary scale.

(10.) The numbers 1184323 and 589 are expressed in the duodenary scale. Divide the former by the latter in that scale.

(11.) Senary scale: $321 + 452 + 534$: $321 \sim 252$: 321×52.

(12.) Reduce 57632 t from undenary to the septenary scale: transform $6538\frac{5}{16}$ into the septenary scale and add them together.

(13.) Multiply 47623 by 5763 in the octenary scale and take the square root of the product in that scale.

(14.) Divide 63245102 by 658 in the septenary scale, and find the square root of 3258967·28743 in duodenary scale.

(15.) Transform 3t·97e from the duodenary to the octenary scale.

(16.) Express $\sqrt{56324{\cdot}673} : 56783 \div 64$; each in nonary scale, and transform 5632101 from septenary to duodenary.

(17.) Express $65384 \div {\cdot}\dot{2}\dot{7}$ in the duodenary scale.

(18.) Extract the square root of 1010001 in the binary scale.

(19.) Apply the duodenary scale to find the square of 4 ft. 2 in. 0′ 2″ 10‴.

(20.) Apply the duodenary scale to find the cube of 16 ft. 10. in.

MENSURATION AND DUODECIMAL ARITHMETIC.

Duodecimal arithmetic is employed chiefly in measurements required by carpenters, plasterers, and bricklayers. The work is simple, and the pupil has only to bear in mind that 12, *not* 10, is the base or radix whenever passing from one denomination to another higher or lower as the case may be. Feet are indicated by f. or ft.; inches by in. or ′; parts or twelfths of an inch by ″, and so on. By some the subdivisions are called firsts, seconds, thirds, fourths; by others primes or parts, seconds, thirds, &c. It will be observed in working that two scales of notation are used, the decimal or ordinary (when dealing with feet only, which are multiplied in the usual way) and duodecimal in passing through the inferior grades or denominations. As Mr. Wood remarks the pence table will be of great service when solving these questions. All problems in this rule can be worked by fractions and frequently with much greater ease. The following results should be carefully commited to memory.

ft. × ft. = sq. ft.
ft. × in. = „ primes ′.
ft. × ″ = „ inches ″.
ft. × ‴ = „ thirds ‴.

in. (′) × in. (′) = (″).
in. (′) × (″) = (‴).
in. (′) × (‴) = (⁗).
(″) × (″) = (⁗).

Illustrative Example.—Multiply 7 ft. 6 in. 5″ by 6 ft. 7 in.

$$\begin{array}{rrrrr}
7 & 6' & 5'' & & \\
6 & 7 & 8 & & \\
\hline
45 & 2 & 6 & & \\
4 & 4 & 8 & 11 & \\
 & 5 & 0 & 3 & 4 \\
\hline
50 & 0 & 3 & 2 & 4
\end{array} = \underline{\underline{50 \text{ sq. ft. } 3\tfrac{7}{36} \text{ sq. in.}}} \text{ Ans}$$

Or by Fractions the work is as follows:—

$$7 \text{ ft. } 6 \text{ in. } 5'' = 7\tfrac{77}{144} \text{ and } 6 \text{ ft. } 7'\ 8'' = 6\tfrac{92}{144} \text{ or } 6\tfrac{23}{36},$$

$$\therefore\ 7\tfrac{77}{144} \times 6\tfrac{23}{36} = \tfrac{1085}{144} \times \tfrac{239}{36}$$
$$= \tfrac{259315}{5184} = 50 \text{ sq. ft. } 3\tfrac{7}{36} \text{ sq. in.}$$

The following rules will be required in the solution of varied questions that are propounded in Duodecimal Ari metic:—

1. To find the area of a Rectangle:—

Area = length × breadth.
Length = area ÷ breadth.
Breadth = area ÷ length.

2. To find the area of a Rhombus:—

Area = length × perpendicular height (or breadth).

3. To find the area of a Triangle:—

a. Area = ½ (base × vertical).
b. To half the sum of the 3 sides add increment each side separately; multiply the half sum the 3 differences together, and take the squ root of the product for the area.

4. To find any side of a Right-angled Triangle given other two:—

the hypotenuse = square root of the sum of the squa of the other two sides.
∴ either side = square root of the difference betwe the squares of the hypotenuse a the other side.

5. To find the area of a regular Polygon:—

Area = ½ (perimeter × vertical from centre to any one si

6. To find the circumference or the diameter of a Circle:—

Circumference $= \frac{22}{7}$ × diameter or $\frac{355}{113}$ × diameter.
∴ Diameter $= \frac{7}{22}$ (or $\frac{113}{355}$) × circumference.

7. To find the area of a Circle:—

a. Area $= \frac{1}{4}$ (circumference × diameter).
b. „ $=$ ·7854 × $(\text{diameter})^2$.
c. „ $=$ ·07958 × $(\text{circumference})^2$.

8. To find various required results in connection with the Circle and its circumscribed and inscribed figures:—

a. Diam. × ·88622 = side of a square equal in area.
b. Circum. × ·28209 = „ „ „
c. Diam. × ·7071 = „ inscribed square.
d. Circum. × ·22508 = „ „ „
e. $\sqrt{\text{area}}$ × ·63662 = „ „ „
f. Side of Square × 1·41421 = diam. of circumscribing Circle.
g. Side of Square × 3·54491 = circum. of a Circle equal in area.
h. Side of Square × 1·12838 = diam. of a Circle equal in area.

9. To find the area of a Circular Ring:—

a. Area = (sum of diameters × difference of diameters × ·7854).
b. Area = difference of areas of the two Circles.
c. Area $= \frac{1}{4}$ (sum of circumferences × difference of diameters).

10. To find the area of an Ellipse:—

Area = product of diameters × ·7854.

11. To find the volume of a Cube:—

Volume or content $= (\text{side})^3$.

12. To find the volume of a Parallelopipedon:—

Volume or content = length × breadth × depth.

13. To find the volume of a Prism or of a Cylinder:—

Volume or content = area of base × vertical height.

14. To find the volume of a Pyramid or Cone:—

Volume or content = area of base × $\frac{1}{3}$ vertical height.

15. To find the volume of a Sphere or Globe:—

$$\text{Volume} = (\text{diam.})^3 \times {\cdot}5236 = (\text{circum.})^3 \times {\cdot}016887.$$

16. To find the convex surface of a Sphere:—

$$\text{Convex surface} = \text{diam.} \times \text{circum.} = (\text{diam.})^2 \times 3{\cdot}14159.$$

17. To find the magnitude or volume of a body from its weight:—

$$\text{Volume (in C. feet)} = \text{weight (Avoir. oz.)} \div \text{specific gravity.}$$

(The S. G. is to be obtained from the tables.)

Exercise 118.

(1.) Find in yds. the side of a square field containing 15 ac. 2 roods 29 poles 3 yds.

(2.) Multiply 2 ft. 7 in. by 3 ft. 5 in. 7 pts. and the result by 2 ft. 11 in. 5 pts.

(3.) A wall whose height is $\frac{1}{8}$ of its length and breadth $\frac{1}{5}$ of its height, contains 54925 cub. inches. Find breadth.

(4.) Find cost of papering a hall 24 ft. 3 in. long 15 ft. 8 in. broad and 11 ft. 6 in. high, @ 4*s*. per sq. yard.

(5.) Multiply 6 ft. 2 in. 11″ by 4 ft. 5 in. and give result in sq. inches.

(6.) 3 ft. 4 in. 7″ × 1 ft. 8 in. 5″ × 4 ft. 11 in.

(7.) 1 ft. 11′ × 4 ft. 3 in. 7″ × 5 ft. 7′ 3″. Give answer in ft. in. &c.

(8.) 4 ft. 7 in. 2″ × 3 ft. 1 in. 5″ × 2 ft. 5′.

(9.) 3 ft. 9 in. 7 pts. × 5 ft. 6 in.

(10.) 6 ft. 11 in. 11″ × 5 ft. 4 in. × 7 ft. 9 in. 10″.

(11.) How much carpet $2{\cdot}\dot{4}$ ft. wide will it take to cover a room $29{\cdot}\dot{5}$ ft. long and $17{\cdot}1\dot{9}$ ft. wide?

(12.) Find cost of painting a cubical box on outside which contains 42·875 cub. ft. @ $1{\cdot}\dot{3}$ shillings per sq. yard.

(13.) 3 ft. 7 in. 5 pts. × 2 ft. 10 in. 11 pts.

(14.) A rectangular field whose breadth is $\frac{1}{3}$ its length contains 6 ac. 900 yds. Find its dimensions.

(15.) A room is 16 ft. 7 in. long 13 ft. 5 in. wide and 10 ft. 6 in. high. Find cost of papering it with paper 1 ft. 8 in. wide @ 10*d*. per yd. and of carpeting it with carpet $\frac{3}{4}$ yd. wide @ 4*s*. 2*d*. per yd.

THE METRIC SYSTEM.

It were a consummation ardently to be desired by every school teacher in the kingdom that the Metric System should be introduced both into our coinage and weights and measures. By a most eminent and practical teacher, known to us, it was said that more could be taught in three months in the Metric System than in twelve months by the present most complicated arrangement of weights and measures, and we quite endorse the opinion.

For all practical purposes the Metric System is simply invaluable, and those who have adopted it are already reaping the immense advantages to be derived from its use. There is not the smallest variation in the working of questions of every denomination, and all the calculations are in the strictest harmony with decimal operations. In France the system is in full development, and the tables furnished in this treatise (pp. 35–36) are those adopted in that country. The *Franc* is the unit of their money, and is worth about 9¾*d.* of our money. The *Mètre* is the unit of length, and is equal to about 39·37 inches nearly, English measurement. The *Are* is the unit of superficial measure, and is nearly equal to 120 English square yards. The unit of Solid Measure is the *Stère*, equal to nearly 35¼ English cubic feet. The *Gramme* is the unit of weight, and weighs about 15½ English grains. Lastly, the *Litre* is the unit of capacity, and answers to our quart, to which it closely approximates.

The Prefixes used in these Metric tables are as follows:—

Deca	stands for	10	times.	Deci	stands for the	10th	part.
Hecto	”	100	”	Centi	”	100th	”
Kilo	”	1000	”	Milli	”	1000th	”
Myria	”	10000	”				

Illustrative Examples.

1. What is the value of 11 kilog. 8 hectog. 9 grammes at 25 fr. 8 dec. 7 centimes per kilog.? (*8 dec. 7 centimes*, or as more generally expressed, *87 centimes*).

The working of this and similar questions is merel matter of decimal multiplication.

$$\begin{array}{r}
11{\cdot}809 \times 25{\cdot}87\phantom{\times 25{\cdot}87} \\
\underline{25{\cdot}87}\phantom{\times 25{\cdot}87} \\
82663\phantom{\times 25{\cdot}87} \\
94472\phantom{0\times 25{\cdot}87} \\
\underline{295225}\phantom{00\times 25{\cdot}87} \\
305{\cdot}49883 = \underline{\underline{305 \text{ fr. } 49 \text{ centimes.}}} \quad \text{Ans.}
\end{array}$$

2. What is the area of a room whose length is 7 me 2 decim. 5 centim., and breadth 4 metres 8 decim.?

Working by the rule of multiplication of decimals we h the following:—

$$\begin{array}{r}
7{\cdot}25 \\
\underline{4{\cdot}8} \\
5800 \\
\underline{2900} \\
34{\cdot}800 = 34{\cdot}8 \text{ sq. metres} \\
= \underline{\underline{34{\cdot}8 \text{ centiares.}}} \quad \text{Ans.}
\end{array}$$

3. If 22 men plough 1 hectare 4 decare 3 are, how m men will plough 3 hectare 5 decare 1 are in same time?

The statement and question become—

22 men = 1·43 hectare.
? „ = 3·51 „

$$\frac{22 \times 3{\cdot}51}{1{\cdot}43} \text{ men} = \frac{\overset{2}{\cancel{22}} \times \overset{27}{\cancel{351}}}{\underset{\cancel{13}}{\cancel{143}}} \text{ men} = (2 \times 27) \text{ men} = \underline{\underline{54 \text{ men.}}} \quad \text{A}$$

4. Find what sum will amount to £1599, 6 fl. 7 c. 2⅕ m. 4¼ years @ 3⅗ °/o.

By Formula (*e*) p. 152,

$$£\frac{100 \times 1599{\cdot}6722}{100 + (4\frac{1}{4} \times 3\frac{3}{5})} = £\frac{159967{\cdot}22}{115{\cdot}3}$$
$$= \underline{\underline{£1387, 4 \text{ fl.}}} \quad \text{Ans.}$$

INVOICES AND COMMERCIAL ACCOUNTS.

From their variety and character the following Invoices are in the highest degree adapted to acquaint the pupil with some of the principal and prevailing styles of Commercial Accounts obtaining in the several departments of business life, and to advance his practical knowledge of mercantile transactions. As even the forms themselves, apart from the body of each invoice, are educational in their character, the pupil should be instructed to carefully copy the Bill, writing his own name in the space allowed for it. He thus supposes himself to be the customer to whom the Invoice of goods purchased is sent. The Extensions (or calculations of the separate prices) should then be made and entered in the money column to the right appointed to receive them, and the total sum of these amounts—subject to any Discounts (or deductions) indicated—will be the answer or Footing of the Invoice. "Invoicing" should be peculiarly a "Home Exercise" to be brought for correction to school, and should not (as the other Rules) constitute ordinary Class-work. The value of a thorough acquaintance with this branch will commend itself to every judgment.

No. 1.

North Street,
Leeds, ... 18

....

Bought of WILSON, ANDERSON, & CO.,
Manufacturers of Cabinet Furniture, Bedding, &c.

240 Wood Chairs, - - - @	3/4			
126 Short Hall Forms, - - ,,	2/9			
13¼ doz. Brass Hat Pegs, - - ,,	9/3			
4 ,, Single Iron Bedsteads (each) ,,	19/6			
4 ,, Palliasses for do. ,, ,,	4/3			
4 ,, Mattresses for do. ,, ,,	£2, 5/6			
	£			

No. 2.

EDINBURGH, ...

....

To M'GREGOR & CO.,

Pianoforte and Music Warerooms, Princes Stree

	4 doz. Song Books, cloth gilt, (each) @	3/2		
	6 „ "Home Sweet Home," „ „	/9¾		
	8 Minuet (De Koutski) Pianoforte Solo, - - - - - - @	1/10		
	10 Instruction Books for Piano, „	/8½		
	1 doz. Organ Pieces, - - (each) „	1/10		
		£		

No. 3.

200 BRISTOL ROAD,

BIRMINGHAM, ...

....

Bought of BATES & CO.,

Galvanized Iron Merchants, Builders of Iron Churches, Schools,

	400 yards Wire Netting, - - @	/6½		
	200 „ „ „ - - „	/5½		
	50 „ „ „ (fine mesh), „	1/1½		
	15 doz. Galvanized Iron Buckets,- „	32/		
	12 „ „ „ „ - „	54/		
	3 „ „ „ Troughs, „	60/		
		£		

No. 4.

BRISTOL MANURE & FELT WORKS,

BRISTOL, ...1

....

To JAMES KIRKWOOD & SONS, D

	8 Frames Sheathing Felt, ea. 500 sheets, @	/3½		
	6 „ „ „ „ „ „ „	/3		
	18 „ Roofing „ „ 100 yds., „	/7½		
	20 „ „ „ „ „ „ „	/6½		
	10 „ Sarking „ „ „ „ „	/9		
	6 „ „ „ „ „ „ „	/7		
	15 Barrels Felt Varnish, „ 20 gallons,	/7½		
		£		

No. 5.

Argyle Street,
Glasgow,.................... 18

....

Bot. of JAMISON & SONS,

Chemists and Druggists, Patent Medicine Vendors, &c.

6 pints Str. Liq. Ammonia, -	@	1/6			
12 pints Sulphurous Acid, - -	„	/8			
8 oz. Tinct. Rhubarb, - -	„	/4			
20 boxes Knapp's Throat Cure, -	„	/10½			
24 boxes Brown's Troches, - -	„	/10½			
16 bars Scented Soap (ea. 3 lbs.),	@ per lb.	/4½			
		£			

No. 6.

High Street,
Birmingham, ... 18

....

To MESSRS. HALLIDAY & SONS, Dr.

Builders, Contractors, &c.

To 4½ days of Slater, - - - - -	8/			
„ 4½ „ Labourer, - - - -	4/			
„ 9 cwts. of Slates, - - - - -	5/			
„ 9 lbs. Slate Nails, - - - -	/4			
„ 12 „ Lead, - - - - - -	/3			
„ 6¼ stone Cement, - - - - -	/6			
	£			

No. 7.

Sauchiehall Street,
Glasgow,.................... 18

....

To THOMAS MURRAY & CO.,

Rope and Twine Manufacturers.
(Netting of all sorts made to order.)

16½ lbs. Twine, - - - - -	/8			
33¼ „ „ - - - - -	1/6			
14½ „ „ - - - - -	1/			
15 Large Hooks and Thimbles, - -	/9			
24 Small „ „ - -	/6			
	£			

No. 8.

SACKVILLE STREET,

DUBLIN, ...

....

In account with ROBERT SMITH & CO

Glass, China, and Earthenware Merchants.

	6 Dinner Sets, - - - -	@	£5, 15/6		
	10 Breakfast Sets, - - -	,,	£3, 3/9		
	8 Tea Sets, - - - -	,,	£2, 15/6		
	10 ,, Superior, - - -	,,	£3, 4/3		
	50 Pie Dishes, - - - -	,,	2/3		
	100 Soup Plates, - - -	,,	/11½		
	45 Jugs, - - - - -	,,	1/3½		
			£		

No. 9.

MARKET STREET,

MANCHESTER, ...1

....

Bought of HENDERSON & ALLEN,

Merchants and Manufacturers,
By Special Appointment to the Queen and Crown Princess of Germa

	18 Flannel Shirts, - - - - -	7/6		
	20 ,, Vests, - - - - -	3/10		
	12 Merino ,, - - - - -	6/9		
	16 ,, Pants, - - - - -	7/3		
	30 Jerseys (knitted), - - - -	5/9		
	24 ,, Boys', - - -	4/10		
		£		

No. 10.

OXFORD STREET,

LONDON, ...18

....

Bought of ADAMSON & HARVEY,

Damask Merchants and Manufacturers.

Terms Nett Cash.

	100 yards Diaper, - - -	@	/10			
	50 „ Roller Towelling, - -	„	/5			
	100 „ „ „ Extra,	„	/7½			
	200 Diaper Towels, - - -	„	1/10			
	40 Glass „ - - - -	„	/9½			
	10 doz. Pillow Cases, - - -	„	22/			
			£			

No. 11.

NOTTINGHAM, ...18

....

Bought of ROBINSON & JONES,

Merchants and Manufacturers.

	12 Superfine Linen Shirts, - -	@	7/10			
	24 Boys' Eton Collars, - -	„	/4¼			
	36 Ladies' Collars, - - -	„	/5¾			
	6 Boys' Fine Linen Shirts, - -	„	4/6			
	2½ doz. Gentlemen's Collars, -	„	6/3			
	16 pairs Boys' Linen Cuffs, - -	„	5/7			
	18 „ Ladies' „ - -	„	6/7			
	20 „ Gents' „ - -	„	7/7			
			£			

No. 12.

Reform Street,
Dundee,......................

....

Bought of WILSON, M'LEOD, & CC
Dundee Room Paper Warehouse.

	30 doz. Hall Marble Paper, - -	@	2/7		
	20 „ Dining-room „ - -	„	5/3		
	24 „ Drawing „ „ - -	„	7/9		
	86 „ Bedroom „ - -	„	2/8		
	12 „ Varnished Oak Paper, -	„	3/3		
	16 „ Kitchen Paper, - -	„	1/10		
	Cr.				
	By 3 doz. Marble Paper, - -	@	2/7		
	„ 5 „ Bedroom „ - -	„	2/8		
			£		

No. 13.

69 Princes Street,
Edinburgh,......................

....

Invoice from WM. MITCHELL & CO.,
Heraldic and General Stationers, Engravers, Lithographers, and Pri

	12 doz. Note Books, - - -	@	3/9		
	1000 Cream Laid Envelopes (Long) per 100, - - - - -	@	1/2		
	1000 Cream Laid Envelopes (Square) per 100, - - - - -	@	1/6		
	20 packets Cream Laid Note (White),	„	2/6		
	12 „ „ „ „ (Pink),	„	2/1		
	16 doz. Drawing Pencils (Various degrees), - - - - -	@	1/6		
	8 doz. Drawing Pins, - - -	„	/10½		
			£		

No. 14.

Bold Street,
Liverpool, ...18

....

Bought of MEADOWS & MOWBRAY,

Linen-drapers & Manufacturers.

Terms Nett Cash.

55½	yds.	White Calico, - -	@	/8½			
173¼	„	Unbleached Calico, -	„	/4½			
89½	„	White Braid, - -	„	/6¼			
46	„	Black „ - -	„	/2½			
33¾	„	Broad White Tape, -	„	/2¾			
69½	„	Stair Covering, - -	„	/6¾			
114¼	„	Pink Silk Ribbon, -	„	/10¾			
32	„	Silk Braid, - - -	„	1/6½			
				£			

No. 15.

Wavertree Manure Works,
Liverpool, ...18

....

To HENRY ROGERS & SONS, Dr.

500	cwt.	Bone Meal Manure, -	@	9/6			
400	„	Turnip Manure, - -	„	7/9			
180	„	Grass „ - -	„	8/3			
360	„	Bone Flour Manure, -	„	10/3			
240	„	Special Manure, - -	„	12/6			
660	„	Potato „ - -	„	8/6			
700	„	Compound, - - -	„	7/9			
				£			

No. 16.

NORWICH, ...

....

Bot. of JOHNSTON & SON,

Cooks and Confectioners.
Importers of French Confectionery, &c.

	6¾ lbs. French Sweets, - - @	3/3		
	12½ ,, English ,, - - ,,	1/8½		
	6 Sultana Cakes (each 2 lb.) per lb. ,,	1/4½		
	20 lbs. Rich Madeira Cake, - ,,	1/10½		
	Dinner for 35 persons, @ (per head)	7/10		
	Tea for 175 persons, ,, ,,	/11½		
	Supper for 4½ doz. persons, ,, ,,	5/10		
		£		

No. 17.

BELFAST, ...

....

Bought of ADAMS & SMITH,

Merchants and Manufacturers.

(By Special Appointment to Her M. Gracious Majesty the Queen.)

	24 pairs Gents' Hose, - - -	1/8		
	18 ,, ,, Lamb's Wool Hose, -	1/10		
	16 ,, Boys' Socks, - - -	1/4½		
	12 ,, ,, ,, (Super.), - -	1/8		
	26 ,, Gents' Kid Gloves, - -	2/3		
	14 ,, ,, ,, ,, (Extra), -	3/1		
	8 ,, Ladies' ,, ,, - -	1/11		
	10 ,, ,, ,, ,, (Extra), -	2/10		
		£		

No. 18.

THE SCOTTISH CARPET AND ROOM-PAPER WAREHOUSE

ARGYLE STREET,
GLASGOW, ...18

....

Bought of SHAW & CO.,

Manufacturers of Carpets, Curtains, Floor-Cloth, &c.

12 Tapestry Rugs, - - - - -	7/9			
24 Thread „ - - - - -	22/3			
36 Door Mats (Thread), - - -	4/8			
132 yds. Kidderminster Carpet, - -	4/3			
66 „ Brussels Carpet (Best Quality),	4/9			
54 „ Binding, - - - - -	/1			
154½ „ Stair Carpet (Brussels), -	3/3			
	£			

No. 19.

68 CHEAPSIDE,
LONDON, ...18

....

To THOMAS WOOD, Dr.

Manufacturer of the Celebrated X A1 Quality Electro Plate
(Registered under the Patents, &c., Act, 1883).

30 doz. Plated Table Spoons (on Nickel), ea. @	1/5			
28½ „ „ „ Forks „ „	1/4			
24 „ „ Dessert „ „ „	1/1½			
36 „ „ „ Spoons „ „	1/1			
32 „ „ Tea „ „ „	/10½			
24 „ „ Egg „ „ „	/7½			
12 „ „ Salt and Mustard Spoons (on Nickel) - - „	/6½			
	£			

No. 20.

63 Union Street,
Aberdeen,.....................

....

To THE DENNIS & DAWSON M'F'G C

Manufacturers and Importers of the celebrated Dennis & Dawson Lock-Stitch Sewing Machines.

	20 Sewing Machines (Hand), -	@	£4, 4/		
	36 „ „ Plain Treadle,	„	£6,10/		
	50 „ „ Extra Strong,	„	£8,10/		
	100 Hand „ and Covers,	„	£4,16/6		
	36 Covers for Treadle Machines,	„	10/6		
	50 sets of Drawers, - - - -	-	12/		
			£		

No. 21.

Regent Square,
Leeds,..................... 1

....

Bought of H. A. GORDON & CO.,

Chemists and Aerated Water Manufacturers,
By Her Majesty's Royal Letters Patent.

	40 Cases Lemonade, each 6 doz.,	@	4/6		
	30 „ Soda Water, „ 10 „	„	4/3		
	30 „ Ginger Ale, „ 6 „	„	4/6		
	20 „ Lime Juice, „ 8 „	„	13/6		
	20 „ Kali Water, „ 8 „	„	4/2		
	40 „ Seltzer Water, „ 6 „	„	4/3		
			£		

Special preparation for Tropical Climates; Bottles and Pack included in above prices.

No. 22.

PRINCES STREET,
EDINBURGH,....................18

....

To ROBERTSON BROS., Dr.

Ironmongers and Manufacturers.
Gas Fitting, Plumbing, Bell Hanging, &c.

5 Mortise Latches, - - - -	2/9			
12 Sets China Furniture, - - -	1/2			
6 Children's Cots, 4′ 6″ × 2′ 6″, - -	29/			
6 Straw Palliasses, - - - -	5/			
6 Best Black Hair Mattresses, - -	24/6			
12 lbs. French Tacks, - - -	/8			
6 doz. Cup Hooks, - - - -	1/6			
	£			

No. 23.

CHESTER STREET,
BRISTOL,....................18

....

To WM. JOHNSTON & CO., Dr.

Italian Warehousemen, Tea Dealers, Provision Merchants, &c.

8 lbs. Black Tea, - - - - -	3/4			
3 stone Sugar, - - - - -	2/4			
5 boxes Salt, - - - - -	/3			
14 stone ,, - - - - -	/1			
3 ,, Rice, - - - - -	2/4			
6 ,, Apple Jelly, - - -	4/8			
3½ ,, Sultanas, - - - -	9/4			
	£			

No. 24.

MOORFIELDS,
SHEFFIELD, ...

....

To MESSRS. GABBY & SONS, D

Painters, Decorators, &c.

(Estimates furnished.)

	16 panes Glass, 15″ × 13″ - - -	/6		
	40 „ „ 19½″ × 13½″ - -	/8		
	16 „ „ 29″ × 15½″ - -	1/2		
	64 „ obsc. 31½″ × 12″ - -	1/5		
	8 „ 32 oz. 39″ × 36″ - -	7/6		
	96 lbs. Putty, 18/; Paint, 16/, - -			
	24 days, £7, 16/; 24 do., £3, 12/, -			
		£		

No. 25.

VICTORIA SQUARE,
PORTSMOUTH,.................... 1

....

Bought of H. A. GORDON & CO.,

Chemists and Aerated Water Manufacturers,
By Her Majesty's Royal Letters Patent.

Freight paid.

	12 Cases Ginger Ale, (each 3 dozen), @	3/6		
	6 „ Lemonade, „ 6 „ „	3/6		
	9 „ Soda Water, „ 3 „ „	3/		
	10 „ Seltzer „ „ 3 „ „	4/		
	12 „ Kali „ „ 3 „ „	4/		
	43 Three-dozen Compartment Cases, „	3/3		
	6 Six-dozen „ „ „	5/6		
		£		

No. 26.

Snow Hill,
Liverpool,....................18

....

Bot. of FISHER BROS.,
Hatters, &c.
(Lincoln & Bennett's Extra Quality Satin Hats.)

6 Satin Hats, - - - -	@	13/6			
5 doz. College Caps, - - -	„	63/			
30 Boy's Caps, - - - - -	„	2/3			
140 „ (special order), -	„	1/10			
12 Extra Satin Hats, - -	„	17/			
3 doz. Hatbands, - - -	„	3/6			
		£			

No. 27.

Oxford St.,
London,....................18

....

To WILLIAMSON & CO., Dr.
Cutlers.

12 doz. Table Knives, No. 103, -	@	6/			
20 „ „ „ „ 105 Riveted,	„	9/			
16 „ Dessert „ „ 95 „	„	5/8			
4 „ Table „ „ 347 „	„	10/			
6 „ „ „ Ivory, „ 130 „	„	28/			
		£			

Make out Bills for the following sets of articles:—

(1.) 5 yds. muslin at 1*s.* 2½*d.* per yard; 39 yds. merino at 4*s.* 3¼*d.* per yd.; 3 dozen buttons at 4¾*d.* per dozen; 198 yds. braid at 1*s.* 3½*d.* per doz. yds.

(2.) 10¼ yards of ribbon at 2¼*d.* per yd.; 13 yds. 2 qrs. 3 nls. of calico at 8*d.* a yard; 106 reels of cotton at 8*d.* a dozen; 10 pieces of tape at 2¾*d.* a piece; 1 umbrella at 10*s.* 6*d.*

(3.) 15 yds. damask at 4*s.* 9*d.* a yard; 28 yds. of gimp at 10½*d.* a yard; 24 rings at 4*s.* 3*d.* per dozen; 24 hooks at 1¾*d.* per dozen; workwoman's time, 2½ days at 2*s.* 3*d.* per day.

(4.) 5½ doz. lb. candles at 8½*d.* per lb.; 8¼ lbs. of wax do. at 2*s.* 3*d.* per lb.; 7 gals. 2½ pints of oil at 4*s.* 8*d.* per gal.; 2 lamps at 13*s.* 9*d.* each.

(5.) 3¼ lbs. of tea at 2*s.* 8*d.* per lb.; 1½ lbs. coffee at 1*s.* 8*d.* per lb.; 6¾ lbs. of sugar at 5*d.* per lb.; ¾ lb. of butter at 1*s.* 5*d.* per lb.

(6.) 27 yds. of flannel at 3*s.* 4*d.* per yd.; 32 yds. of calico at 5½*d.* per yd.; 3½ doz. stockings at 8*s.* 4*d.* per doz.; 6 pairs of gloves at 3*s.* 6*d.* per pair; 4 collars at 1*s.* 5½*d.* each.

(7.) 2 doz. pairs of gloves at 2*s.* 11½*d.* a pair; 37 yds. chintz at 9¾*d.* a yd.; a gross buttons at 3¼*d.* a doz.; 164 yds. fringe at 1*s.* 3¾*d.* a doz. yds.

(8.) 12 bars of soap, each weighing 3½ lbs., at 5½*d.* per lb.; 164 lbs. of tea at 30*s.* per doz. lbs.; 12 packets of candles, each containing 6½ lbs., at 11½*d.* per lb.

(9.) 17½ yds. of silk at 11*s.* 7½*d.* a yard; 648 buttons at 1*s.* 9½*d* a gross; 15½ yds. of velvet at 1*s.* 11½*d.* a yd.; 153 reel of cotton at 11*d.* a doz.

(10.) 10 lbs. sugar at 5*d.* per lb.; 6 lbs. of tea at 3*s.* 8*d.* per l 8 lbs. coffee at 1*s.* 4*d.* per lb.; 12 lbs. currants at 5¾ per lb.; 10 lbs. rice at 4½*d.* per lb.; 9 lbs. cheese at 1 per lb.

(11.) $\frac{5}{16}$ of a yd. at £2 per yd.; $\frac{13}{16}$ yd. at 2*s.* 6*d.* per 38$\frac{16}{17}$ yds. at £7, 15*s.* 8¾*d.* per yd.; 2¼ yds. at £1, 12*s.* per yd.

MENTAL ARITHMETIC.

One aim of this Treatise is to engender in the minds of the pupils a tendency to abandon slate or written work, and a preference for mental computations in their arithmetical labours. Those who thus depend almost entirely upon their own unaided powers, as a rule become most proficient in the art. Throughout the book it will be observed how the theories and rules have conduced to this result, and it ought to be a case of rare occurrence to find one who, having reached the present stage, is not an adept at what is commonly called "Mental Arithmetic."

The rules and exercises that now follow, however, may be classed more strictly under this heading, as the majority of them are to be worked without any written aid whatever.

If the class that is being practised in "Mental Arithmetic" have the additional interest infused by what is recognized as "taking places," more pleasant and profitable work will be accomplished and a higher degree of proficiency ultimately attained.

It is hardly requisite to supply directions either to the Teacher or Student, but a very excellent method of using these exercises is to dictate at a somewhat slow rate twenty or more questions continuously, the class writing down *at once* as many of the answers as can be secured. After changing books or slates amongst themselves the pupils may correct their answers as the amounts are read out by the officer in charge of the class.

No explanations of the rules are appended; but, where the reason of the rule is not self-evident, the explanation should be furnished by the teacher and one or two illustrative questions worked on the blackboard. By this means the rules will be rendered intelligible, and the processes less mechanical. Five or seven minutes' daily exercise in this section will greatly promote general arithmetical slate work, and afford an entertaining variation in the routine of the class.

Generally the calculations will be found to increase in difficulty as the exercises proceed, but this rule is not without exception.

RULE CXIX.

To find the price of any number of articles @ 10*s.*, 6*s.* 8*d.*, 5*s.*, 4*s.*, 3*s.* 4*d.*, 2*s.* 6*d.*, 2*s.*, 1*s.* 8*d.*, 1*s.* 4*d.*, 1*s.* 3*d.*, or 1*s.* each.

1°. Divide the given number of articles by 2 (for 10*s.*), 3 (for 6*s.* 8*d.*), 4 (5*s.*), 5 (4*s.*), 6 (3*s.* 4*d.*), 8 (for 2*s.* 6*d.*), 10 (2*s.*), 12 (1*s.* 8*d.*), 15 (1*s.* 4*d.*), 16 (1*s.* 3*d.*), 20 (1*s.*), and the result will be the required answer in pounds.

Exercise 119.

Find the value of—

(1.) 24
(2.) 36
(3.) 48
(4.) 60
(5.) 72
(6.) 84
(7.) 96
(8.) 108
(9.) 16
(10.) 32
(11.) 40
(12.) 56
(13.) 64
(14.) 80
(15.) 88
(16.) 100
(17.) 116
(18.) 120
(19.) 132
(20.) 144

@ 10*s.*, 5*s.* and 2*s.* 6*d.* each.

(21.) 12
(22.) 18
(23.) 24
(24.) 30
(25.) 36
(26.) 42
(27.) 48
(28.) 54
(29.) 60
(30.) 66
(31.) 72
(32.) 78
(33.) 84
(34.) 90
(35.) 96
(36.) 102
(37.) 108
(38.) 114
(39.) 120
(40.) 126

@ 6*s.* 8*d.*, 3*s.* 4*d.* and 1*s.* 8*d.* each.

Find the value of—

(41.) 40
(42.) 60
(43.) 80
(44.) 100
(45.) 120
(46.) 140
(47.) 160
(48.) 180
(49.) 200
(50.) 220
(51.) 240
(52.) 260
(53.) 280
(54.) 300
(55.) 320
(56.) 340
(57.) 360
(58.) 380
(59.) 400
(60.) 420
@ 4*s*., 2*s*., and 1*s*. each.

(61.) 32
(62.) 40
(63.) 48
(64.) 56
(65.) 64
(66.) 72
(67.) 80
@ 1*s*. 3*d*. each.

(68.) 30
(69.) 45
(70.) 60
(71.) 75
(72.) 90
(73.) 105
(74.) 120
@ 1*s*. 4*d*. each.

Rule CXX.

To find the price of any number of articles @ 16*s*. 8*d*. each.

1°. Add a cipher to the number of articles, divide the result by 12, and the quotient is the answer in pounds.

Note.—In this and subsequent rules the teacher can give the explanation necessary. Here 16*s*. 8*d*. = $\frac{10}{12}$ of £1.

Exercise 120.

Tell the value of—

(1.) 12 @ 16*s*. 8*d*. each.
(2.) 24 „ „ „
(3.) 48 „ „ „
(4.) 60 „ „ „
(5.) 96 „ „ „
(6.) 36 „ „ „
(7.) 72 „ „ „
(8.) 84 @ 16*s*. 8*d*. each.
(9.) 108 „ „ „
(10.) 132 „ „ „
(11.) 120 „ „ „
(12.) 144 „ „ „
(13.) 168 „ „ „
(14.) 156 „ „ „
(15.) 180 „ „ „

RULE CXXI.

To find the price of any number of articles @ £1, 1
or £3, 6*s.* 8*d.* each.

1°. Add a cipher to the number of articles, divide b
3, and the quotient is the answer in pounds.

Exercise 121.

Tell the value of—

(1.) 12 @ £1, 13*s.* 4*d.* and @ £3, 6*s.* 8*d.* each.
(2.) 18 „ ” ” ” ”
(3.) 24 „ ” ” ” ”
(4.) 36 „ ” ” ” ”
(5.) 42 „ ” ” ” ”
(6.) 48 „ ” ” ” ”
(7.) 60 „ ” ” ” ”
(8.) 78 „ ” ” ” ”
(9.) 54 „ ” ” ” ”
(10.) 84 „ ” ” ” ”
(11.) 96 „ ” ” ” ”
(12.) 120 „ ” ” ” ”
(13.) 132 „ ” ” ” ”
(14.) 138 „ ” ” ” ”
(15.) 144 „ ” ” ” ”
(16.) 15 „ ” ” ” ”
(17.) 30 „ ” ” ” ”
(18.) 45 „ ” ” ” ”
(19.) 75 „ ” ” ” ”
(20.) 90 „ ” ” ” ”
(21.) 27 „ ” ” ” ”
(22.) 33 „ ” ” ” ”
(23.) 39 „ ” ” ” ”
(24.) 51 „ ” ” ” ”
(25.) 57 „ ” ” ” ”
(26.) 63 „ ” ” ” ”
(27.) 72 „ ” ” ” ”
(28.) 81 „ ” ” ” ”
(29.) 93 „ ” ” ” ”
(30.) 102 „ ” ” ” ”

Rule CXXII.

To find the price of any number of articles @ £1, 5*s.* or 2, 10*s.* each.

1°. Add a cipher to the number and divide by 8 or 4. The sult will be the answer in pounds.

Exercise 122.

Tell the value of—

(1.) 4 @ £1, 5*s.* 0*d.* and @ £2, 10*s.* 0*d.* each.
(2.) 8 „ „ „ „ „
(3.) 12 „ „ „ „ „
(4.) 16 „ „ „ „ „
(5.) 20 „ „ „ „ „
(6.) 24 „ „ „ „ „
(7.) 28 „ „ „ „ „
(8.) 32 „ „ „ „ „
(9.) 36 „ „ „ „ „
(10.) 40 „ „ „ „ „
(11.) 96 „ „ „ „ „
(12.) 88 „ „ „ „ „
(13.) 48 „ „ „ „ „
(14.) 80 „ „ „ „ „
(15.) 56 „ „ „ „ „
(16.) 72 „ „ „ „ „
(17.) 64 „ „ „ „ „
(18.) 104 „ „ „ „ „
(19.) 112 „ „ „ „ „
(20.) 120 „ „ „ „ „

Rule CXXIII.

To find the simple interest of any sum lent out @ 10 °/o for or more years.

1°. Take one-tenth of the given sum and multiply the result by the number of years.

Exercise 123.

ind the interest of the following sums @ 10 °/o lent periods mentioned against each:—

.) £100 for 1, 2, 3, 4 and 5 yrs.
2.) £120 " " "
(3.) £70 " " "
(4.) £80 " " "
(5.) £90 " " "
(6.) £110 " " "
(7.) £60 " " "
(8.) £50 " " "
(9.) £130 " " "
(10.) £140 " " "
(11.) £200 for 1, 2, 3, 4 and 5 y
(12.) £300 " " "
(13.) £900 " " "
(14.) £400 " " "
(15.) £800 " " "
(16.) £700 " " "
(17.) £600 " " "
(18.) £500 " " "
(19.) £550 " " "
(20.) £660 " " "

RULE CXXIV.

To find the simple interest on any sum lent out at 5 °/o any given number of years.

1°. Take one-twentieth of the given sum and multiply result by the number of years.

Exercise 124.

Find the simple interest of the following sums lent for the periods mentioned:—

(1.) £20 for 1, 2, 3, 4 and 5 yrs.
(2.) £100 " " "
(3.) £40 " " "
(4.) £80 " " "
(5.) £60 " " "
(6.) £120 " " "
(7.) £180 " " "
(8.) £160 " " "
(9.) £200 " " "
(10.) £140 " " "
(11.) £10 for 2, 3, 4 an
(12.) £30 " "
(13.) £50 " "
(14.) £70 " "
(15.) £90 " "
(16.) £110 " "
(17.) £130 " "
(18.) £150 " "
(19.) £170 " "
(20.) £190 " "

RULE CXXV.

To find the value of a dozen articles, given the price of one article.

1°. Call the pence shillings, and for ¼*d.*, ½*d.*, or ¾*d.* add 3*d.*, 6*d.*, or 9*d.* respectively.

Exercise 125.

Find the price of a dozen articles at each of the following prices:—

	d.		*d.*		*s.*	*d.*		*s.*	*d.*		*s.*	*d.*		*s.*	*d.*
(1.)	2¼	and	2¾	(11.)	1	1½	and	1	1¾	(21.)	2	2	and	2	2¾
(2.)	3½	,,	3¾	(12.)	1	2¼	,,	1	3¼	(22.)	2	3½	,,	2	3¾
(3.)	4¾	,,	5	(13.)	1	3½	,,	1	4½	(23.)	2	4¼	,,	2	5¼
(4.)	5¼	,,	6¼	(14.)	1	4¾	,,	1	5¼	(24.)	2	5¾	,,	2	6¾
(5.)	6½	,,	7½	(15.)	1	5½	,,	1	6½	(25.)	2	7½	,,	2	8¼
(6.)	7¾	,,	8¾	(16.)	1	6¾	,,	1	7¼	(26.)	2	8¾	,,	2	9¾
(7.)	8¼	,,	9¼	(17.)	1	7½	,,	1	8½	(27.)	2	9¼	,,	2	10¼
(8.)	9½	,,	10½	(18.)	1	8¾	,,	1	9¾	(28.)	2	10¾	,,	2	11¾
(9.)	10¾	,,	11¼	(19.)	1	9¼	,,	1	10¼	(29.)	2	11½	,,	3	0¾
(10.)	11¾	,,	12¾	(20.)	1	10¾	,,	1	11½	(30.)	3	1¼	,,	3	3¾

RULE CXXVI.

The price of one article being given, to find the price of two or more dozens.

1°. Find the price of *one* dozen by last Rule.

2°. Multiply this result by the number of dozens given.

Exercise 126.

Find the value of 2, 3, 4, 5 and 6 dozens of articles respectively at the subjoined prices:—

	d.		*d.*		*d.*		*s.*	*d.*
(1.)	7¾	(6.)	6¼	(11.)	10¼	(16.)	1	0½
(2.)	8½	(7.)	7¼	(12.)	11½	(17.)	1	2¼
(3.)	9¼	(8.)	8¼	(13.)	11¾	(18.)	1	4½
(4.)	10¾	(9.)	9½	(14.)	5½	(19.)	1	6½
(5.)	11¼	(10.)	10½	(15.)	5¾	(20.)	1	8½

RULE CXXVII.

To find the price of 240 articles, the price of one article being given.

1°. Call the pence pounds; a farthing, 5*s.*; a halfpenny, 10*s.*; and three farthings, 15*s.*

Exercise 127.

Find the price of 240 articles at the subjoined prices:— .

	s.	*d.*		*s.*	*d.*		*s.*	*d.*		*s.*	*d.*
(1.)	0	5	(9.)	2	4	(17.)	0	9½	(24.)	1	8¾
(2.)	0	7	(10.)	3	6	(18.)	0	10¾	(25.)	1	10¼
(3.)	0	9	(11.)	0	2¼	(19.)	0	6¼	(26.)	2	8½
(4.)	0	11	(12.)	0	3½	(20.)	1	0¾	(27.)	3	6¾
(5.)	1	1	(13.)	0	5¾	(21.)	1	2½	(28.)	4	7½
(6.)	1	3	(14.)	0	7½	(22.)	1	4¾	(29.)	5	10¾
(7.)	1	7	(15.)	0	11¾	(23.)	1	7½	(30.)	6	9½
(8.)	1	8	(16.)	0	8¾						

RULE CXXVIII.

To find the price of one article, the price of a dozen being given.

1°. Consider each shilling in the given price as 1*d.*, each 9*d.* as ¾*d.*, each 6*d.* as ½*d.*, and each 3*d.* as ¼*d.*

Exercise 128.

Find the price of one article at the following prices per dozen:—

	s.	*d.*		*s.*	*d.*		*s.*	*d.*		*s.*	*d.*
(1.)	10	0	(5.)	12	3	(9.)	18	9	(13.)	21	9
(2.)	8	0	(6.)	13	3	(10.)	9	9	(14.)	33	6
(3.)	6	0	(7.)	14	6	(11.)	17	3	(15.)	37	9
(4.)	4	0	(8.)	15	6	(12.)	19	6			

RULE CXXIX.

To find the value of 1 gross, the price of one article being given.

1°. Multiply the price (in pence) of each article by 12 and call the product shillings, reducing to pounds if more than 20.

2°. Call each farthing 3*s.* 0*d.*, each halfpenny 6*s.* 0*d.*, and *each 3* farthings 9*s.* 0*d.* extra.

Exercise 129.

Find the value of one gross articles at each of the following prices:—

(1.) 4*d.* each.
(2.) 5*d.* ,,
(3.) 6*d.* ,,
(4.) 7*d.* ,,
(5.) 8*d.* ,,
(6.) 9*d.* ,,
(7.) 10*d.* ,,
(8.) 11*d.* ,,
(9.) 12*d.* ,,
(10.) 13*d.* ,,

(11.) 2½*d.* each.
(12.) 3¼*d.* ,,
(13.) 4½*d.* ,,
(14.) 5¼*d.* ,,
(15.) 6½*d.* ,,
(16.) 2¾*d.* ,,
(17.) 4¾*d.* ,,
(18.) 6¾*d.* ,,
(19.) 8¾*d.* ,,
(20.) 10¾*d.* ,,

(21.) 3¾*d.* each.
(22.) 5¾*d.* ,,
(23.) 7¾*d.* ,,
(24.) 9¾*d.* ,,
(25.) 11¾*d.* ,,
(26.) 6¼*d.* ,,
(27.) 9½*d.* ,,
(28.) 10¼*d.* ,,
(29.) 11½*d.* ,,
(30.) 12¾*d.* ,,

Rule CXXX.

To find from the price of one article the value of 1000 articles.

1°. Multiply £25 by the number of sixpences in the price per article.

2°. For each odd penny above the number of sixpences add £4, 3*s.* 4*d.* to product obtained by 1°.

Exercise 130.

Find the value of 1000 articles at the prices given:—

s. *d.*
(1.) 0 1 each.
(2.) 0 3 ,,
(3.) 0 6 ,,
(4.) 0 9 ,,
(5.) 1 0 ,,
(6.) 1 3 ,,
(7.) 1 6 ,,
(8.) 2 0 ,,
(9.) 2 6 ,,
(10.) 3 0 ,,
(11.) 3 6 ,,
(12.) 4 0 ,,
(13.) 4 6 ,,
(14.) 5 0 ,,

s. *d.*
(15.) 5 6 each.
(16.) 6 0 ,,
(17.) 6 6 ,,
(18.) 7 0 ,,
(19.) 7 6 ,,
(20.) 8 0 ,,
(21.) 1 2 ,,
(22.) 1 4 ,,
(23.) 1 5 ,,
(24.) 1 7 ,,
(25.) 1 8 ,,
(26.) 1 10 ,,
(27.) 2 1 ,,

s. *d.*
(28.) 2 7 each.
(29.) 3 3 ,,
(30.) 8 6 ,,
(31.) 9 0 ,,
(32.) 9 6 ,,
(33.) 10 0 ,,
(34.) 10 6 ,,
(35.) 11 0 ,,
(36.) 12 6 ,,
(37.) 14 0 ,,
(38.) 15 6 ,,
(39.) 16 0 ,,
(40.) 17 0 ,,

RULE CXXXI.

To find the value of acres, roods, and poles, at so
acre.

1°. Call the acres pounds; count each rood as five s
and each pole as three halfpence.

2°. Multiply the sum of the items obtained in 1°
price (in pounds sterling and fractions of a pound).

Exercise 131.

Find the value of—

(1.) 1 ac. 1 ro. 10 po.
(2.) 1 „ 2 „ 20 „
(3.) 1 „ 3 „ 30 „
(4.) 2 „ 1 „ 10 „
(5.) 2 „ 2 „ 20 „
(6.) 2 „ 3 „ 30 „
(7.) 3 „ 3 „ 20 „
(8.) 4 „ 2 „ 20 „
(9.) 4 „ 3 „ 30 „
(10.) 5 „ 3 „ 10 „
(11.) 6 „ 2 „ 30 „
(12.) 6 „ 3 „ 20 „
(13.) 7 „ 2 „ 10 „
(14.) 7 „ 3 „ 30 „
(15.) 8 „ 2 „ 20 „
(16.) 8 „ 3 „ 30 „
(17.) 9 „ 2 „ 20 „
(18.) 10 „ 1 „ 10 „
(19.) 11 „ 3 „ 30 „
(20.) 12 „ 3 „ 30 „

@ £1, £3, £4, £5, £1, 10*s.*, £4, 10*s.*, £6, 10*s.*, £13, 10*s.* per

RULE CXXXII.

To find the value of a given weight in cwts., qrs.,
at so much per cwt.

1°. Count the cwts. as pounds sterling, each quarte
shillings, and each lb. as 2⅐ pence.

2°. Multiply the sum of the 3 amounts obtained i
the price (in pounds sterling and fractions of a pound

Exercise 132.

Find the value of—

(1.) 1 cwt. 2 qrs. 14 lbs.
(2.) 2 „ 3 „ 21 „
(3.) 3 „ 2 „ 7 „
(4.) 4 „ 2 „ 7 „
(5.) 5 „ 3 „ 21 „
(6.) 6 „ 2 „ 14 „
(7.) 7 „ 3 „ 14 „
(8.) 8 „ 3 „ 14 „
(9.) 9 „ 2 „ 21 „
(10.) 10 „ 2 „ 21 „

@

£	*s.*	*d.*
1	0	0
2	0	0
3	0	0
5	0	0
2	10	0
12	10	0

per cwt.

Rule CXXXIII.

To find the price of any number of articles @ 4*s.* 2*d.* or 8*s.* 4*d.* each.

1°. Add a cipher to the number of articles and divide the augmented quantity by 48 or 24 respectively.

2°. Call the quotient pounds sterling for the answer.

Exercise 133.

Find the value of—

(1.) 1234
(2.) 3456
(3.) 4567
(4.) 5678
(5.) 6789
(6.) 2345
(7.) 7891
(8.) 8912
(9.) 9123
(10.) 8765

@ 4*s.* 2*d.* and 8*s.* 4*d.* each.

Rule CXXXIV.

To find the wages of a man for a year of 313 days, not counting Sundays.

1°. Take the pence as pounds; add 6 times as many shillings and one day's wages. The sum will be the answer.

Exercise 134.

(1.) @ 3*d.*; 5*d.*; 7*d.*; 9*d.*;
(2.) „ 2*d.*; 4*d.*; 6*d.*; 8*d.*;
(3.) „ 11*d.*; 13*d.*; 15*d.*; 17*d.*;
(4.) „ 10*d.*; 12*d.*; 14*d.*; 16*d.*;
(5.) „ 2½*d.*; 3½*d.*; 4½*d.*; 5½*d.*;
(6.) „ 6¼*d.*; 7¼*d.*; 8¼*d.*; 9¼*d.*;
(7.) „ 10¾*d.*; 11¾*d.*; 12¾*d.*; 13¾*d.*;
(8.) „ 2¾*d.*; 3¾*d.*; 4¾*d.*; 5¾*d.*;
(9.) „ 6¾*d.*; 7¾*d.*; 8¾*d.*; 9¾*d.*;
(10.) „ 14½*d.*; 16½*d.*; 18½*d.*; 20½*d.*;

per day, for a days.

Rule CXXXV.

To find the True Discount, the rate and Banker’ being given.

1°. Divide the rate by 100 increased by the rate.

2°. Multiply the quotient so obtained by the Discount and add the product incrementally to th Discount. Or this rule may be thus stated: Find the between the Banker’s Discount and the True Disco Banker’s Discount. This difference is the True required.

Note.—The Present Worth of any amount pa future date is such a sum as, placed at interest for time and at the given rate, will with its accrued int the given amount. The True Discount is the int accruing; and it is calculated, not on the amount its its Present Worth.

Exercise 135.

Find the True Discount from the Banker’s Discou rate:—

	£	*s.*	*d.*			£	*s.*	*d.*
(1.)	53	16	8	@ 6¼ °/ₒ.	(7.)	34	15	6
(2.)	106	4	6	„ 5 „	(8.)	169	0	0
(3.)	11	18	0	„ 5 „	(9.)	23	17	9
(4.)	22	19	4	„ 4 „	(10.)	33	17	3
(5.)	190	9	0	„ 4 „	(11.)	102	2	3
(6.)	38	5	4	„ 2½ „	(12.)	16	0	0

RULE CXXXVI.

To find the Banker's Discount from the True Discount, the rate being given.

1°. Find the Simple Interest on the True Discount. Add both together and the sum will be the Banker's Discount required.

Note.—Banker's Discount is exactly the same as the Simple Interest on the given sum.

Exercise 136.

Find the Banker's Discount (or Simple Interest) from the True Discounts as given, and at the respective rates %.

	£	s.	d.			£	s.	d.	
(1.)	20	0	0	@ 6⅔ %.	(7.)	129	13	4	@ 5 %.
(2.)	101	6	8	„ 6¼ „	(8.)	44	11	8	„ 4 „
(3.)	22	13	4	„ 5 „	(9.)	216	13	4	„ 4 „
(4.)	202	6	8	„ 5 „	(10.)	44	3	4	„ 4 „
(5.)	30	6	8	„ 5 „	(11.)	366	5	0	„ 4 „
(6.)	43	0	0	„ 5 „	(12.)	74	13	4	„ 2½ „

RULE CXXXVII.

To find the True or Banker's Discount when the difference between the two is given, rate being named.

1°. Divide 100 by the given rate and multiply the given difference by the quotient; this gives the True Discount. Or divide 100 times the given difference by the given rate.

2°. Divide 100 plus the given rate by that rate and multiply the given difference by the quotient; this gives the Banker's Discount. Or divide the product of the given difference into 100 plus the given rate by that rate.

Exercise 137.

Find the True and the Banker's Discounts from the following differences at the given rates:—

	£	s.	d.			£	s.	d.	
(1.)	0	10	0	@ 2½ %.	(4.)	3	15	0	@ 3 %.
(2.)	2	0	0	„ 2½ „	(5.)	4	5	2	„ 3½ „
(3.)	3	10	0	„ 3 „	(6.)	4	15	1	„ 3½ „

	£	s.	d.					£	s.	d.		
(7.)	5	0	0	@	4	°/ₒ.	(14.)	3	8	9	@	5½ °/ₒ.
(8.)	5	10	0	,,	4	,,	(15.)	5	0	0	,,	6 ,,
(9.)	6	0	0	,,	4⅙	,,	(16.)	4	4	0	,,	6 ,,
(10.)	6	6	0	,,	4⅙	,,	(17.)	0	12	6	,,	6¼ ,,
(11.)	2	10	0	,,	5	,,	(18.)	2	10	0	,,	6¼ ,,
(12.)	3	5	0	,,	5	,,	(19.)	3	0	1	,,	7 ,,
(13.)	4	8	0	,,	5½	,,	(20.)	4	6	4	,,	7 ,,

RULE CXXXVIII.

To find the gain or loss from cost and selling price.

1°. The gain or loss multiplied by the fraction $\frac{\pounds 100}{\text{C. P.}}$ wil give the gain or loss °/ₒ.

Exercise 138.

			£	s.	d.		£	s.	d.	
(1.)	Bot. goods	for	258	16	8	sold for	271	15	6	
(2.)	,,	,,	629	3	4	,,	654	6	8	
(3.)	,,	,,	495	3	0	,,	536	8	3	
(4.)	,,	,,	270	6	8	,,	263	11	6	
(5.)	,,	,,	1064	11	8	,,	1043	5	10	
(6.)	,,	,,	762	18	1½	,,	712	0	11	
(7.)	,,	,,	229	2	6	,,	252	0	9	
(8.)	,,	,,	196	0	0	,,	205	16	0	
(9.)	,,	,,	1888	15	0	,,	1926	10	6	
(10.)	,,	,,	276	6	0	,,	299	6	6	
(11.)	,,	,,	1027	16	0	,,	1092	0	9	
(12.)	,,	,,	3057	5	0	,,	3133	13	7½	Fir gair loss
(13.)	,,	,,	85	8	4	,,	77	12	9	
(14.)	,,	,,	141	13	4	,,	126	1	8	
(15.)	,,	,,	170	16	8	,,	131	10	10	
(16.)	,,	,,	518	6	8	,,	492	8	4	
(17.)	,,	,,	1567	3	9	,,	1504	10	0	
(18.)	,,	,,	1594	0	0	,,	1461	3	4	
(19.)	,,	,,	175	0	0	,,	192	10	0	
(20.)	,,	,,	350	0	0	,,	357	0	0	
(21.)	,,	,,	225	0	0	,,	234	0	0	
(22.)	,,	,,	125	0	0	,,	140	12	6	
(23.)	,,	,,	325	0	0	,,	349	7	6	
(24.)	,,	,,	400	0	0	,,	413	6	8	

In business an almost universal practice peculiar to nearly every description of monetary transactions is to make a reduction on the amount or footing of a bill or account when payment is made. These reductions are given for various reasons, such as prompt cash payments, the purchase of large quantities, &c. &c. The common term Discount is generally used for these allowances, and 5 %, 7 %, or 12 % Discount simply means in this reference an abatement to that extent on the amount of the account. The following rules relate exclusively to this subject, the first being the *General Method*, comprehending all possible questions, whilst those coming after are special cases of the first where abbreviated work is admissible and therefore advisable.

All the calculations of the subsequent exercises are intended to be absolutely mental. No shillings or pence are given in the gross amounts for obvious reasons.

RULE CXXXIX.

To find the abatement or Discount on the amount of an a/c at any given rate %.

1°. Multiply the given amount by the rate and divide by 100.

Exercise 139.

Find the Discounts on the following sums at the given rates %.

$$\left.\begin{array}{rl}(1.) & \pounds 500\\ (2.) & \pounds 400\\ (3.) & \pounds 300\\ (4.) & \pounds 150\\ (5.) & \pounds 450\\ (6.) & \pounds 360\\ (7.) & \pounds 244\\ (8.) & \pounds 333\\ (9.) & \pounds 541\\ (10.) & \pounds 728\end{array}\right\} @\ 3, 6, 7, 8, 9, 11\ \%.$$

RULE CXL.

To find abatement or discount on footing of an
2½, 5, 10, or 20 °/o.
1°. Take $\frac{1}{80}$ (for 1¼ °/o); $\frac{1}{40}$ (for 2½ °/o); $\frac{1}{20}$ (
$\frac{1}{10}$ (for 10 °/o); or $\frac{1}{5}$ (for 20 °/o) of the amount of t
the result will be the abatement required.

Exercise 140.

What are the discounts on the following su
specified rates °/o?

(1.) £2000
(2.) £3000
(3.) £5000
(4.) £6000
(5.) £7000
(6.) £2500
(7.) £3500
(8.) £4500
(9.) £5500
(10.) £6600
@ 1¼, 2½, 5, 10, and

RULE CXLI.

To find abatement or discount on footing of an
6¼, 12½, and 25 °/o.
1°. Take $\frac{1}{32}$ (for 3⅛ °/o); $\frac{1}{16}$ (for 6¼ °/o); $\frac{1}{8}$ (for 12
$\frac{1}{4}$ (for 25 °/o) of the amount of the a/c, and the res
the abatement required.

Exercise 141.

What are the discounts indicated in following it

(1.) £320
(2.) £480
(3.) £640
(4.) £800
(5.) £960
(6.) £1120
(7.) £1280
(8.) £1600
(9.) £1920
(10.) £2240
@ 3⅛, 6¼, 12½, and

RULE CXLII.

To find discount or abatement on footing of an a/c @ 2 °/o or 4 °/o.

1°. Take one fiftieth or one twenty-fifth of the amount and the result will be the abatement required.

Exercise 142.

Find abatements in accordance with given items:—

(1.)	£2000	@ 2 and 4 °/o.	(6.)	£3500	@ 2 and 4 °/o.
(2.)	£3000		(7.)	£4500	
(3.)	£4000		(8.)	£5500	
(4.)	£5000		(9.)	£6500	
(5.)	£6000		(10.)	£7500	

RULE CXLIII.

To find the abatement or discount on footing of an a/c @ $4\frac{1}{6}$, $8\frac{1}{3}$, $16\frac{2}{3}$, or $33\frac{1}{3}$ °/o.

1°. Take $\frac{1}{24}$ (for $4\frac{1}{6}$ °/o), $\frac{1}{12}$ (for $8\frac{1}{3}$ °/o), $\frac{1}{6}$ (for $16\frac{2}{3}$ °/o), or $\frac{1}{3}$ (for $33\frac{1}{3}$ °/o) of the amount of the a/c, and the result will be the abatement required.

Exercise 143.

Find the abatements indicated in the items below:—

(1.)	£480	@ $4\frac{1}{6}$, $8\frac{1}{3}$, $16\frac{2}{3}$, and $33\frac{1}{3}$ °/o.	(6.)	£360	@ $4\frac{1}{6}$, $8\frac{1}{3}$, $16\frac{2}{3}$, and $33\frac{1}{3}$ °/o.
(2.)	£720		(7.)	£600	
(3.)	£1200		(8.)	£840	
(4.)	£1440		(9.)	£1080	
(5.)	£960		(10.)	£1320	

RULE CXLIV.

To find the abatement or discount on footing of an $6\frac{2}{3}$ or $3\frac{1}{3}\,^{\circ}/_{\circ}$.

1°. Take $\frac{1}{15}$ (for $6\frac{2}{3}\,^{\circ}/_{\circ}$) or $\frac{1}{30}$ (for $3\frac{1}{3}\,^{\circ}/_{\circ}$) of the amo the a/c, and the result will be the required abatement.

Exercise 144.

Find the abatements indicated in the subjoined items

(1.) £1500
(2.) £2700
(3.) £4500
(4.) £4800
(5.) £7500
(6.) £300
(7.) £900
(8.) £1200
(9.) £3600
(10.) £6000
(11.) £200
(12.) £500
(13.) £800
(14.) £1100
(15.) £1400

@ $6\frac{2}{3}$ and $3\frac{1}{3}\,^{\circ}/_{\circ}$.

(16.) £1700
(17.) £2000
(18.) £2200
(19.) £2300
(20.) £2500
(21.) £100
(22.) £90
(23.) £60
(24.) £50
(25.) £40
(26.) £95
(27.) £85
(28.) £75
(29.) £65
(30.) £55

@ $6\frac{2}{3}$ an

MISCELLANEOUS QUESTIONS
AND EXAMINATION PAPERS.

I. MISCELLANEOUS QUESTIONS.

SET AT OXFORD AND CAMBRIDGE LOCAL EXAMINATIONS.

In the following sets of questions, all taken from Examination Papers, regard has been paid to the requirements of pupils who have given the preceding text a fair amount of thoughtful study. The examples will be found specially adapted to evoke the highest powers of the pupils in discovering the best methods of solution. Many of these problems will admit of everal modes of work, and it is only by that diligent and daily practice which a school curriculum imposes, that the best method or methods will be recognized. It has been the author's practice for a considerable time to prescribe short sets of mixed questions for home work in the various classes, and o invite the pupils to find out the best and shortest solutions. This plan has been attended with most satisfactory results: some of the more ingenious scholars often presenting abbreviations of a wonderful kind, and thus contributing an interest to the subject which has proved as salutary as it was contagious.

(1.) Write down in figures five hundred and one million five hundred and one thousand and eighteen.

(2.) If the carriage of $5\frac{1}{4}$ cwts. for 114 miles be 4*s*. 8*d*., how far should $3\frac{1}{2}$ cwts. be carried for the same money?

(3.) The income-tax being reduced from 7*d*. to 5*d*. in the pound, I save £28, 2*s*. 6*d*. yearly. What is my income?

(4.) What is the dividend on £3469, 10*s*. @ 15*s*. $6\frac{1}{2}$*d*. in the pound?

(5.) Calculate the cost of paving a court-yard 35 ft. 10 in. long and 18 ft. 6 in. broad @ 6*s*. 3*d*. per square yard.

(6.) How much coffee @ 1*s.* 10½*d.* per lb. must be given for 78 lbs. of tea @ 5*s.* 1½*d.*?

(7.) An estate pays 4*s.* 4½*d.* in the pound. What is the loss on a claim for £432, 12*s.*?

(8.) How many yards of carpet, 2 ft. 4 in. wide, will a square room require whose side is 17 ft. 6 in. long?

(9.) What sum will amount to £188, 2*s.* 6*d.* in eighteen months at 5 °/o?

(10.) What length of paper, 27 in. broad, will be required for a room 18 ft. long, 12 ft. broad, and 11 ft. high?

(11.) Add together $\frac{7}{9}$ of £1, 10*s.* 4½*d.*, ⅘ of £2, 8*s.* 4*d.*, and $\frac{3}{7}$ of half a guinea.

(12.) The rates are struck on 80 °/o of a rental of £1850 @ 9*d.* in the pound. What is the amount of the rate?

(13.) Three wheels making 60, 36, and 24 revolutions in a minute, start with certain points in their circumferences downwards, when will they first come altogether again in the same position?

(14.) The seconds pendulum being 1·0872 yards long, express its length in French mètres to 4 places of decimals (1 mètre = 39·3708 inches).

(15.) If a certain MS. fill 6 printed sheets, each containing 32 pages and each page 24 lines with 9 words in each line, how many lines of 12 words each must there be in a page in order that another similar MS. twice as long may fill 3 sheets, each having 48 pages?

(16.) Find by practice the cost of 227 tons 7 cwts. 84 lbs. of coals @ 18*s.* 4*d.* per ton.

(17.) If 40 shillings weigh 7 oz. 5 dwts. and contain 10 dwts. 21 grs. of alloy, how much pure silver is there in one shilling?

(18.) From 2¾ of 11*s.* 8*d.* take 1½ of 17*s.* 2½*d.* and reduce the remainder to the fraction of 13*s.* 5¼*d.*

(19.) If the duty on 2 cwts. 3 qrs. 5 lbs. be £2, 18*s.* 8¼*d.*, what is the rate per cwt.?

(20.) If 1 lb. of metal containing copper and zinc in the ratio of ·84 to ·16 be mixed with 2 lbs. containing the same metals in the ratio of ·75 to ·25, find how much copper and zinc there is in the mixture.

(21.) How many yards @ 18*s.* 3*d.* per yard should be given for 24 English ells @ 13*s.* 8¼*d.* per ell?

(22.) What will it cost to paper a room 6 yds. 1 ft. 1 in. long, 6 yds. 0 ft. 4 in. broad, and 12 ft. high, with paper $\frac{1}{6}$ of a yard wide @ 4½*d.* per yard?

(23.) Find by practice the rent of 39 ac. 2 ro. 18 po. @ £2, 5*s.* per acre.

(24.) If 13 cwts. 2 qrs. 16 lbs. cost £15, 17*s.* 6½*d.* what will 3 tons 1 cwt. 1 qr. 16 lbs. cost?

(25.) The annual premium on a fire insurance is £13, 5*s.* 3*d.*, the duty charged on it will be £19, 17*s.* 10½*d.* How much per cent of the premium is the duty?

(26.) When eggs are 24 a shilling, how many can be bought for £1, 11*s.* 5½*d.*?

(27.) A buys 600 yards of silk @ 3*s.* 4½*d.* per yard, and having sold 360 yards @ 4*s.* 6*d.* per yard and 81 yards @ 3*s.* 9*d.* per yard, he was robbed of the rest. Calculate his total loss or gain, and also loss or gain per cent.

(28.) A man having three sons, aged respectively 24, 16, and 8 years, left his estate to be divided amongst them in proportion to their ages. Eight years afterwards the second son died and left his share to be divided between his surviving brothers in amounts inversely proportional to their ages. What portion of the original estate had each of the two sons after this accession to their property?

(29.) Find area of a flag-stone 5 ft. 3 in. by 2 ft. 8 in.

(30.) A man receives 13*s.* 5*d.* for a week of 7 days. What is the amount of his wages from 1st April to Christmas-day, both inclusive?

(31.) A chain is 22 yards long and is divided into 100 links. How many square links are there in 2½ acres?

(32.) A man buys milk @ 2½*d.* per quart, then dilutes it with water and sells the mixture @ 3*d.* per quart. His profits are 60 °/ₒ. How much water is mixed with each quart of milk?

(33.) A man can copy 3 pages in an hour and a half. How long will it take three men working half as rapidly to copy 36 pages of another volume the pages of which contain $\frac{1}{3}$ as much again as those of the former?

(34.) What is beef per lb. when 4 cwts. cost 16 guineas?

(35.) If interest on £125 for 3 years be £13, 2*s.* 6*d.*, what will be the interest on £200 for 5 years at the same rate?

(36.) If 1 acre cost £1, 13*s.*, what will be the cost of a field 1 furlong 20 poles long by 10 poles 1 yard broad?

(37.) Reduce 4 oz. 7 dwts. 12 grs. to the fraction of 5 oz. Troy, and 14*s.* 7½*d.* to decimal of £5.

(38.) Reduce $1\cdot0\dot{1}$ to a vulgar fraction in lowest terms, and divide 27·36 by $3\cdot1\dot{0}\dot{9}$.

(39.) If a cub. foot of marble weigh 2·716 times as much as a cub. foot of water, find the weight of a block 9 ft. 6 in. long, 2 ft. 3 in. broad, and 2 ft. thick, supposing a cub. foot of water to weigh 1000 ounces.

(40.) 1296 bricks (exposed surface of which = 9½ in. by 4½) are used in paving a certain yard. How many tiles 6 in. square would be required for a yard ⅑ of the size?

(41.) The business of a company produces £24299, 14*s.* 5*d.*; of this £14487, 16*s.* 11*d.* goes for expenses, the remainder is divided among 100 shareholders. How much does each get?

(42.) 12 bushels cost £4, 1*s.*.6*d.* What can be bought for £55, 0*s.* 3*d.*?

(43.) Divide £954, 9*s.* between A, B, and C, so that A is to B as 3 is to 5 and B to C as 10 to 11.

(44.) Sugar is bought at £25 a ton; refining costs £1, 1*s.* 8*d* per cwt.; it is sold at 5½*d.* per lb. What is gain °/ₒ?

(45.) Find the difference between $\frac{3}{11}$ of £78, 16*s.* 2½*d.* an £35, 14*s.* 8¼*d.* ÷ 1⅔.

(46.) If 4 yds. 2 ft. 6 in. cost £4, 14*s.* 3*d.*, what will 5 yds. 3 i cost?

(47.) Find value of 257 barrels @ £1, 17*s.* 9*d.* per barrel.

(48.) A person buys equal quantities of apples at 2 and at 3 a penny respectively, and then mixes them. How many must he sell for 5*s.* so as neither to gain nor lose?

(49.) I lost ⅓ of my property and then had £1562, 3*s.* 4*d.* left. What did I lose, and what had I at first?

(50.) What is the value of 40 lbs. of standard gold if 1 oz. be worth £3, 17*s.* 10½*d.*?

(51.) What will it cost to paper a room 5 yds. 1 ft. 2½ in. long, 5 yds. 3½ in. broad, 4 yds. high, with paper 9 in. wide @ 2½*d.* per yard?

(52.) Compare the simple and compound interest on £119 at the end of 3 years at 4 °/ₒ per annum.

(53.) How many sovereigns are there in 80 lbs. of standard gold @ £3, 17*s.* 10$\frac{1}{2}$*d.* per oz.?

(54.) How many planks, each 13$\frac{1}{2}$ ft. long and 10$\frac{1}{2}$ in. wide, will make a platform 54 yds. long and 21 yds. broad, and what will be the cost @ 5$\frac{1}{2}$*d.* per sq. foot?

(55.) A man buys 500 qrs. at 56*s.* a quarter. He sells $\frac{1}{2}$ of it at 6*s.* per bushel. At what rate must he sell the remainder so as to gain £25 on the transaction?

(56.) Compare the simple and compound interest on £10, 10*s.* at the end of 3 years @ 5 °/o per annum.

(57.) Find the cost of 7 cwts. 2 qrs. 24 lbs. @ £1, 7*s.* 5*d.* per cwt.

(58.) Add together $\frac{1}{3}$ of half a crown, $\frac{1}{6}$ of a guinea, $\frac{4}{15}$ of £1, and $\cdot01\dot{3}$ of £1, 5*s.*

(59.) Compare the simple and compound interest on £10, 8*s.* at the end of 3 years @ 4 °/o.

(60.) Find the value of ·45 of 4*s.* 2*d.* + $\cdot\dot{4}$ of 3*s.* 9*d.* + $\frac{2}{7}$ of 2*s.* 11*d.*

(61.) Divide 16 by ·002 and ·002 by 1·6; also reduce 10*s.* 4*d.* to the decimal of £1, 7*s.* 6*d.*

(62.) What will £4250 amount to in 2$\frac{1}{2}$ years @ 5 °/o compound interest?

(63.) A school-room is 25 ft. long by 20 ft. wide. How many children will it accommodate, allowing 8 superficial feet for each child? If the room is 10 ft. 4 in. high, what cubical space is there for each child?

(64.) Find the difference between 3$\frac{1}{27}$ of 2 qrs. 25 lbs. and ·25 of 4 cwts. 2 qrs. 20 lbs.

(65.) In a thanksgiving procession the route was 7 miles; there were on an average 20 rows of spectators on each side, and each person occupied 15 in. of frontage. Calculate the number of spectators.

(66.) Prove that ·3 of £1 + ·4 of 3*s.* 7$\frac{3}{4}$*d.* + ·5 of 1*d.* is equal to $\cdot\dot{6}$ of 11*s.* 3*d.*

(67.) If 10 oz. 13 dwts. 16 grs. of gold worth £3, 5*s.* per oz. be mixed with 1 oz. 2 dwts. 8 grs. of silver worth 5*s.* per oz., how much worthless alloy must be added to reduce the value to £2, 16*s.* 8*d.* per oz.?

(68.) Coal is raised in price 50 °/o. By how much °/o must I reduce my consumption so as not to increase my expenditure?

(69.) What is the present value of an annuity of £885, 10*s.* for 3 years, the first payment due 1 year hence, @ 5 $^{\circ}/_{\circ}$?

(70.) A cistern without a lid is 5 ft. 3 in. long, 3 ft. 7 in. wide, and 2 ft. 5½ in. high. Find its internal surface and the cost of painting it @ 4*d.* per sq. foot.

(71.) Divide £45 among three persons in the proportion of 3, 5 and 7.

(72.) What length of paper 14 in. wide will cover the walls of a room 15 ft. by 13 ft. and 10 ft. high?

(73.) A merchant buys a fifty-gallon cask of wine for £62, 10*s.* and sells it @ 26*s.* per gall. What is his gain $^{\circ}/_{\circ}$?

(74.) Find the value of $\frac{2}{15}$ guinea + $5\frac{5}{9}$ of 8*s.* 9*d.* − $\frac{8}{7}$ of half a crown.

(75.) A postman receives 15*s.* weekly, is fined 1*s.* 6*d.* if he comes in late, and receives £8, 15*s.* 6*d.* at end of 13 weeks. How often was he late?

(76.) By selling apples 3 a penny 5 $^{\circ}/_{\circ}$ gain is obtained. Find gain or loss $^{\circ}/_{\circ}$ @ 25 for 6*d.*

(77.) Reduce £3, 17*s.* 6*d.* and £14, 10*s.* 7½*d.* each to decimal of £1, and divide second result by first.

(78.) Find value of ·00009765625 of 1 ton.

(79.) Express in words MMMDCCCLXXIV.

(80.) 13 persons earn £116, 7*s.* 8*d.* each, 8 earn £93, 0*s.* 9*d* each. What is the average earned per man?

(81.) Assuming 1 gallon of water to contain 277 cubic inches and that a cubic foot of water weighs 1000 oz., sho that the popular rule a pint of water weighs 1 lb. a a quarter is nearly true.

(82.) Which is the greater—£$\frac{1}{25}$ or $\frac{1}{24}$ of a florin?

(83.) If money is worth $3\frac{3}{4}$ $^{\circ}/_{\circ}$, what should be the price of th 3 $^{\circ}/_{\circ}$ consols?

(84.) A, B, and C rent a field for £180. A puts in 12 horses for 5 months and 45 sheep for 3 months; B puts in 15 oxen for 6 months and 54 sheep for 2 months; C puts in 6 horses and 47 oxen for 3 months. 4 horses and 3 sheep together eat as much as 5 oxen and 1 horse, and 2 oxen eat as much as 7 sheep. What should A, B, and C pay respectively to the landlord as their shares of the rent?

(85.) What is the amount of poor rates on £4736, 5*s*. at 2*s*. 8*d*. in the pound?

(86.) Find the income-tax on £16241, 5*s*. at 1*s*. 1*d*. in the pound.

(87.) Of a new company 2562 shares at £20 each are taken. What must be the call per share to raise £8967?

(88.) A's income consists of £330 paid at Lady-Day and £220 at Michaelmas. On the £330 he pays income-tax at the rate of 5*d*. in the pound. On his whole income he pays 9*d*. What does he pay on the £220?

(89.) The diagonal of a square is 90 feet. Find cost of mowing the square at 1*s*. per 9 square yards.

(90.) A earns £1 in 3 days, A and B earn £9 in 12 days, B and C earn £35, 10*s*. in 42 days. Compare rates of wages of A, B, and C.

(91.) The telegraph posts being 60 yards apart, show that twice the number passed per minute gives roughly the rate in miles per hour.

(92.) If a man rows 3 miles against a stream running 2½ miles per hour, how far can he row in 3½ hours with the stream?

(93.) Write in words 4261000807006.

(94.) If it cost £135 for a wall 150 ft. long, 9 ft. high, how much will a wall 200 ft. long and 8 ft. high cost?

(95.) Find value of 6 pockets of hops, each 1 cwt. 3 qrs. 14 lbs., at £3, 12*s*. 6*d*. per cwt.

(96.) Find square root of 96432400.

(97.) A square board contains 64·064016 sq. feet. Find its diagonal.

(98.) A merchant buys wine at 16*s*. 6*d*. and 10*s*. 6*d*. per gallon; he mixes them in the proportion of 5 at 10*s*. 6*d*. to 7 at 16*s*. 6*d*. At what price per gallon must he sell the mixture to gain 25 °/ₒ?

(99.) A wins a race of 100 yards from B by 17 yards, and from C by 8 yards. How many yards start ought C to give B in 200 yards that they may run a dead heat?

(100.) A train starting from Cambridge at 9·22 reaches London (the distance being 57½ miles) at 11. How long would such a train be in reaching the sun, the distance being 95 millions of miles and the year 365¼ days?

(101.) Four thalers 12 dollars 10 florins and 3 guineas amoun to £7, 2*s*. If a dollar be 4*s*. 2*d*. what is the value o a thaler?

(102.) Find the value of ·00625 of £50, and express $\cdot 2\dot{6}\dot{3}$ o £1, 7*s*. 6*d*. as the decimal of £20.

(103.) A man owes one creditor 1000 guineas, to each of tw others £500, and to each of three others £150. Hi assets are £600. What does each creditor receive i the gross and in the pound?

(104.) Reduce 16*s*. 7½*d*. to decimal of £1.

(105.) A man has 3 vessels: A is empty, B is full of wate and C full of wine. A holds 1 gall., B 2 galls., an C 4 galls. He fills A from B, and replenishes B fro C, and then empties A into C. When he has don this twice what will be the proportion of the wine i B to the water in C?

(106.) Extract the cube root of 2924·207.

(107.) A train going 66 ft. per second starts on a journey 405 miles at 9 o'clock; when will it reach its destin tion?

(108.) A, B, C agree to pay their hotel bill in the ratio of 4 5 to 6. A pays the first day's bill, £2, 10*s*. 10*d*., the second, £3, 12*s*. 2*d*., and C the third, £3, 17 How must they arrange?

(109.) What will it cost to line a cistern without a lid (the inside only), 12 ft. 9 in. long, 8 ft. 3 in. broad, and 6 ft. 6 in. deep, with lead, at £1, 8*s*. per cwt. (1 sq. foot = 8 lbs.)?

(110.) The length of a room is double the breadth, the cost of colouring the ceiling at 4½*d*. per sq. yard is £2, 12*s*. 1*d*., and the cost of painting the 4 walls at 2*s*. 4*d*. per sq. yard is £35. Find its height.

(111.) Find the square root of 25816561 and of 258·16561 to three places.

(112.) Add together 10, $7\frac{4}{9}$, $\frac{5}{27}$, $4\frac{2}{3}$, and $3\frac{1}{3}$ of $\frac{1}{9}$.

(113.) Reduce 3 ac. 1 ro. 20 po. to the fraction of 21 acres.

(114.) Express the difference between $2\cdot\dot{5}3\dot{5}$ and 2·535 by a circulating decimal and also by a vulgar fraction.

(115.) The area of a square field is 824464 sq. yards. Find its side.

(116.) A person invests £2852 in shares at 115, paying £5 per share annual dividend. He sells out at 125 and invests in the 3 $^{\circ}/_{\circ}$ consols at 93. Find the change in his income.

(117.) A bookseller sells 3000 copies at 41*s.* each, and takes in exchange a bill at six months. How much would he gain or lose by selling them for cash at 39*s.* each, money being at 5 $^{\circ}/_{\circ}$?

(118.) Reduce to simplest form: $(\frac{3}{8} - \frac{5}{12} + \frac{8}{15} - \frac{3}{20} - \frac{1}{120}) \times \frac{2}{7} \times 1\frac{3}{4}$.

(119.) Reduce to simplest form: $\frac{3}{4}$ of $(2 + 7\frac{1}{3}) + \frac{7}{8} + \frac{44}{5}$ of $\frac{25}{26}$ of $(11 - 3\frac{10}{11})$.

(120.) What fraction is £8, 6*s.* 8*d.* of £50?

(121.) Find the square root of 49674304.

(122.) Reduce 9 ac. 2 ro. $4\frac{39}{50}$ po. to the decimal of 22 acres 26 poles.

(123.) Add together $\frac{2}{3}$ of $\frac{1}{7}$ of $8\frac{3}{4}$ and $\frac{1}{4}$ of $\frac{2}{5}$ of $2\frac{6}{7}$.

(124.) Divide ·00307326 by 3·013.

(125.) Add ·0625 of 2*s.* 8*d.*, $\cdot\dot{2}$ of 2*s.* $7\frac{1}{2}$*d.*, ·8375 of £1, and reduce the result to the decimal of £7.

(126.) What fraction of $\frac{3}{29}$ of £3, 19*s.* 9*d.* is equal to $\frac{2}{5}$ of £1, 2*s.*?

(127.) If an express run 40 miles per hour and an ordinary 30 miles per hour, and if the express fare is $\frac{1}{4}$*d.* per mile more than the ordinary, find what a man's time is worth if it cost him the same to travel by one as by the other.

(128.) A certain number divided by 243 gives 1306 as quotient with remainder 92. What is the number?

(129.) Show that £12, 14*s.* $4\frac{1}{2}$*d.* is contained as many times in £203, 10*s.* as 12 cwts. 3 qrs. 21 lbs. in 207 cwts.

(130.) A grocer buys 300 lbs. of tea at 2*s.* $4\frac{1}{2}$*d.* per lb., 60 lbs. of it being damaged the price of this is reduced to 1*s.* 9*d.* per lb. What is the cost of the whole?

(131.) Find the difference between $\frac{1}{3}$ of $\frac{4}{7}$ of $\frac{3}{5}$ and $\frac{1}{6}$.

(132.) If a cub. foot of gold may be made to cover 432,000,000 sq. inches, find the thickness of the coating.

(133.) By selling cloth at 8*s.* 9*d.* per yard 5 $^{\circ}/_{\circ}$ gain is secured. What percentage of loss or gain will ensue from selling at 7*s.* 9*d.* per yard?

(134.) A tourist changes his English money in Paris for 23 nap 12 fr. 50 c. He had at starting £23, 12*s.* 6*d.* Wha has he spent if 1 nap. = 20 fr., 1 fr. = 100 c., and 25 fr 20 c. = £1 sterling?

(135.) A box with a lid is made of $1\frac{1}{2}$ in. deal. The externa dimensions are 3 ft. 6 in., 2 ft. 6 in., and 1 ft. 9 in Find amount of deal used.

(136.) Fifteen cwts. of rice are bought for £24, 10*s.* and sold fo £31, 10*s.* What is the selling price per lb.?

(137.) If 2 horses are worth as much as 5 oxen, and 3 oxen a much as 16 sheep, what will be the price of a horse i a sheep is worth £3, 15*s.*?

(138.) Find value of $\frac{4}{5}$ ac. + $\frac{1}{36}$ ro. + $\frac{8}{9}$ poles.

(139.) How many tiles 7 in. square will be required for a floo 19 ft. 3 in. by 13 ft. 5 in.?

(140.) What decimal of £1 is $\frac{3}{7}$ of $3\frac{1}{9}$ of 4*s.* 11*d.*?

(141.) Simplify $17\frac{1}{9} \div 3\frac{3}{10} - 1\frac{1}{6}$ of $\frac{5}{12}$.

(142.) A floor 21 ft. 8 in. × 16 ft. 6 in. is covered with a carpet 27 in. wide at 3*s.* $4\frac{1}{2}$*d.* per yard. Find cost.

(143.) £3500 of 3 $^{\circ}/_{\circ}$ stock is left by will to be transferred to a person 18 months from date. Find present worth of the legacy if stock be at $91\frac{1}{2}$ during the period and rate of discount $4\frac{1}{2}$ $^{\circ}/_{\circ}$.

(144.) A mixture of coffee and chicory in the proportion of 8 to 1 is sold at cost price, 2*s.* per lb. The chicory is worth 4*d.* per lb., what is the value of the pure coffee per lb.?

(145.) Two wheels, A and B, are set in motion simultaneously along a road at the rate of 6 and 7 miles per hour respectively. The circumference of A is 40 in. and of B 36 in. How often will the same points which were in contact with the ground at starting be simultaneously in contact during the first hour of their progress?

(146.) The walls of a room 21 ft. long, 15 ft. 9 in. wide, 11 ft. 8 in. high are painted for £9, 12*s.* 6*d.* How much extra will be charged for painting the ceiling at the same rate?

(147.) A cub. foot of water weighs $62\frac{1}{2}$ lbs. A room 18 ft. 9 in. by 13 ft. 4 in. is flooded to a depth of 2 inches. Find weight of water in the room.

(148.) Find value of $\frac{1}{2} - \frac{1}{3} + \frac{1}{4} - \frac{1}{5} + \frac{7}{10}$.

(149.) Find value of $\frac{1}{4}$ of 17*s.* 8*d.* + 2·625 of 1*s.* − $\frac{3}{4}$ of $\frac{5}{8}$ of 5*s.* 4*d.* + $\cdot 26\dot{3}$ of 25*s.*, and reduce the result to the decimal of £5.

(150.) Divide ·2107206 by 42·06.

(151.) Three ducks are worth 4 chickens, 3 geese are worth 10 ducks. Find value of a goose if a pair of chickens costs 4*s.* 6*d.*

(152.) Find simple interest of £63, 5*s.* 9*d.* for $10\frac{1}{2}$ years at $3\frac{1}{4}$ °/$_\circ$.

(153.) Find the value of $343\frac{3}{4}$ articles at £2, 16*s.* $10\frac{1}{2}$*d.* each.

(154.) Subtract ·992748 from 1 and divide result by ·0074.

(155.) Multiply $9\cdot\dot{1}4285\dot{7}$ by ·109375.

(156.) Find value of $\frac{3}{8}$ of £1, 10*s.* + $\frac{2}{3}$ of $1\frac{1}{2}$ of $\frac{4}{5}$ of £1, 5*s.* − ·5625 of £1.

(157.) Reduce 2 cwts. 3 qrs. 3 lbs. 8 oz. to decimal of a ton.

(158.) Show that simple interest on £450 for 7 months at 4 °/$_\circ$ per annum is equal to discount on £460, 10*s.* for same time and at same rate °/$_\circ$.

(159.) Add $\frac{5}{17} + \frac{2}{51} + \frac{3}{34}$, and divide the product of $7\frac{3}{4}$ and $9\frac{1}{31}$ by the difference of 9 and $6\frac{1}{5}$.

(160.) Find the value of $\cdot\dot{5}\dot{4}$ of $\cdot 30\dot{2}\dot{7}$ of 1 mile 6 fur. 12 poles.

(161.) A cubical block contains 9 cub. ft. 1029 cub. in. Find number of sq. yards, &c., in its surface.

(162.) Find a sum of money such that $5\frac{2}{13}$ of it shall be equal to 7·2 of £5, 3*s.* $9\frac{1}{12}$*d.*

(163.) A paper is worked by 2500 pupils of whom $\frac{1}{5}$ are girls the rest boys; 5 °/$_\circ$ of the boys fail and 40 °/$_\circ$ of the girls. What percentage of the whole number passed?

(164.) A gives B 10 yards start and C 15 yards in a race of 100 yards. How much should B give C in 150 yards?

(165.) What is the value of a block 5 ft. 3 in. by 2 ft. 4 in. by 1 ft. 2 in. at 4 guineas per cub. foot?

(166.) If 4 men working 7 hours a day do a work in 5 days and 1 hour, how many hours a day must 6 men work to do twice as much in 6 days and 4 hours, allowing for a half-holiday on one of the 6 days?

(167.) Simplify $\dfrac{3\frac{1}{2} - 1\frac{7}{8}}{3\frac{1}{4} \times 2\frac{1}{2}}$.

(168.) Find the square root of 144·7209.

(169.) Find the value of $\cdot 8\dot{3}$ of 13*s.* 4*d.* + $\cdot 13\dot{8}$ of £1, 4*s.* and express result as decimal of £5.

(170.) An imperial gallon contains 277·274 cub. inches, and a cub. foot of water weighs 1000 oz. avoirdupois. Find the weight of a pint of water correct to the one-thousandth part of an ounce.

(171.) Find the value of $\dfrac{3}{\sqrt{19} - 4}$ correct to 4 places of decimals.

(172.) What sum of money paid now will discharge a debt of £1000 due in two half-yearly instalments at 5 °/₀ per annum?

(173.) Five town workmen can do as much work as 9 country workmen. What would be the difference to a contractor between employing 15 town men or 10 town and 12 country men to do a piece of work which the 15 workmen could do in 10 days—town men being paid 7*s.* 6*d.* and country 4*s.* 6*d.* a day?

(174.) The circumferences of the fore and hind wheels of a carriage are 13 ft. 9 in. and 16 ft. 6 in. respectively. How far has the carriage travelled when the fore-wheel has made 768 more revolutions than the hind-wheel?

(175.) Find value of $\cdot 3\dot{4}\dot{5}$ of 9*s.* 2*d.* + $\frac{5}{6}$ of ·075 of £10 + ·05 of 1·125 of £1, 13*s.* 4*d.*, and reduce result to decimal of £50.

(176.) A man buys some eggs at 2 a penny, 4 times the number at 5*d.* a dozen, 5 times the number at 8*d.* a score, and 10 times the number at 3*s.* 2$\frac{1}{3}$*d.* per hundred. He sells the whole at 6*d.* a dozen. Find his gain °/₀.

(177.) Simplify $\dfrac{\frac{1}{2} + \frac{1}{3} + \frac{1}{4}}{\frac{2}{5} + \frac{2}{7} + \frac{2}{9}}$, also $3\frac{1}{125}$ of $3\frac{4}{7} \div (\frac{47}{345}$ of 9).

(178.) What sum of money will amount to £699, 13*s.* 2·4*d.* in 2 years, reckoning compound interest for 1 year at 4 °/₀ and for the other at 3$\frac{1}{2}$ °/₀?

(179.) A man saves £150 every year, and invests it at the end of the year at 5 °/₀ compound interest. Find the amount of his savings at the end of the fourth year.

Fifty thousand soldiers are to be raised in 4 provinces which contain respectively 175002, 82434, 22116, and 20448 men fit for service. Find the number which each must supply.

A man spent £12, 18*s.* 8*d.* in gloves at 2*s.* 8*d.* per pair. Some faded, and he sold the rest for £14, 13*s.* 10*d.* at 3*s.* 5*d.* the pair. How many were faded?

Find the value of 5 lbs. 8 oz. 9 dwts. at 5*s.* 10*d.* per ounce.

Reduce $\frac{4844}{5536}$ and $\frac{7623}{8316}$ to lowest terms, and divide their sum by $1\frac{19}{24}$.

Convert $3{\cdot}064\dot{8}1\dot{4}$ to a vulgar fraction in its lowest terms.

Express $\frac{13}{29}$ of $\frac{8}{39}$ of 9 days 16 hours + ·0390625 of 10 days 16 hours to decimal of $23\frac{1}{2}$ days.

If 4 men earn as much as 7 women, and 1 woman as much as 2 boys; and if 6 men, 10 women, and 14 boys, working together for 8 days, earn £22, what will be the earnings of 8 men and 6 women working together for 10 days?

A debt of £65 is paid in francs at $9\frac{3}{4}$*d.* each at a time when 25 francs are worth £1. What does the creditor gain or lose?

Find the discount on a bill of £397, 2*s.* due half a year hence at 5 °/ₒ per annum.

A person travelled 480 miles by sea, rail, and coach. The distance by coach was $\frac{1}{3}$ that by rail, and the distance by rail $\frac{3}{20}$ that by sea. The cost by coach was $\frac{2}{3}$ that by rail, the cost by rail $\frac{3}{10}$ that by sea. What did the whole journey cost, coach fare being 4*d.* per mile?

Find the value of 128 tons 15 cwts. 3 qrs. 24 lbs. at £16, 6*s.* 8*d.* per ton.

Simplify $\frac{1\frac{1}{2}}{8\frac{1}{3}}$ of $\frac{1\frac{1}{2}+1\frac{1}{3}}{2\frac{3}{8}-1\frac{1}{6}}+\frac{2\frac{1}{5}+4\frac{1}{3}}{1\frac{1}{5}-\frac{1}{9}}$ of $\frac{1}{9}$.

A mètre is defined to be $\frac{1}{10000000}$ of the one-fourth part of the circumference of the earth, and is equal to 39·37079 inches. Find the circumference of the earth in miles.

(193.) Express as vulgar fractions ·01875, $\cdot 24\dot{9}$, and $\cdot 124\dot{9}$.

(194.) Divide 85·9625 by 26·45 and also by ·02645.

(195.) The *Times* issued this morning (Tuesday, Dec. 12, 1876) is numbered 28,810. Find the number of the first copy of the *Times* which was published in 1876.

(196.) How many times is 2 cwts. 2 oz. contained in 6 tons 8 cwts. 8 lbs.?

(197.) Find the value of $3\frac{1}{2} + 2\frac{1}{12} + 3\frac{3}{16} - 7\frac{19}{24}$.

(198.) A, B, and C rent a field for £25, 12*s.* 5*d.* A puts in 15 sheep for 6 months, B 45 sheep for 8 months, C 81 sheep for 4 months. What should they each pay towards the rent?

(199.) Reduce $\frac{595}{1071}, \frac{1547}{5712}$ to their lowest terms and express their difference as a decimal.

(200.) What is the length of the edge of a cubical cistern which contains as much as a rectangular one whose edges are 154 ft. 11 in., 70 ft. 7 in., and 53 ft. 1 in.?

II. INTERMEDIATE ARITHMETIC.

SET AT VARIOUS EXAMINATIONS.

(1.) A box 3 ft. deep and 2 ft. square on the top contains 100 apples; what must be the depth of a box 2 ft. by 3 ft. on the top which contains 350?

(2.) If the 4*d.* loaf weigh 72 oz. when wheat is at 77*s.* a quarter, what should the 3*d.* loaf weigh when wheat is at 81*s.* per quarter?

(3.) At what rate simple interest will £112, 10*s.* amount to £128, 5*s.* in 4 years?

(4.) In what time will £2675, 4*s.* 2*d.* amount to £3036, 7*s.* $2\frac{3}{4}$*d.* @ 6 °/$_\circ$ simple interest?

(5.) I invest £5187, 10*s.* in the 3 per cents @ 83, but afterwards transfer three-fifths of this sum to the 4 per cents @ 96. How is my income affected?

(6.) If 5 oxen or 7 horses eat up the grass of a field in 87 days, in what time will two oxen and three horses eat it up?

(7.) If $2\frac{1}{3}$ bushels cost $\dfrac{2+\frac{1}{3}}{3+\frac{1}{2}}$ of £1, what will $793\frac{1}{16}$ bushels cost?

(8.) How many yards of matting 2 ft. 6 in. broad will cover a floor 27 ft. long by 20 ft. broad?

(9.) If a family of 9 persons spend £120 in 8 months, how much will a family of 24 spend in 16 months?

(10.) If the sum of £1200 be put out at 10 °/o per annum comp. interest, paid half-yearly, what will it amount to in $1\frac{1}{2}$ years?

(11.) Find the G.C.M. of 918, 1928, and 522.

(12.) At what rate per cent per annum simple interest will £776, 15*s.* amount to £978, 14*s.* $1\frac{1}{5}$*d.* in $6\frac{1}{2}$ years?

(13.) I buy tea at 2*s.* 3*d.* per lb. and other tea at 3*s.* 6*d.* In what way must I mix them, so that by selling the mixture at 4*s.* a lb. I may realize 20 °/o?

(14.) A dealer buys a damaged cargo for £530, spends 7 °/o on the cost price in preparing it for the market; he sells it at 120 °/o profit, receiving for it the same gross sum as is received by another dealer who buys a sound cargo and sells it at 32 °/o profit. Find cost of sound cargo.

(15.) If by selling an article at 8*s.* 3*d.* $17\frac{1}{2}$ °/o be lost, what price would have secured 40 °/o gain?

(16.) What number multiplied by 64 will give the same product as 864 multiplied by 408?

(17.) A grocer bought 6 hhds. of sugar each weighing 3 cwts. 2 qrs., and sold to A $17\frac{1}{2}$ lbs., to B $1\frac{1}{2}$ cwt., to C 1 cwt. 2 qrs. 8 lbs., and to D 1 qr. 18 lbs. What had he left?

(18.) A gentleman gave £2 to his 3 sons, A, B, and C, in proportion to their respective ages, which were $12\frac{3}{4}$, $9\frac{3}{4}$, and $7\frac{1}{2}$. What was each son's share?

(19.) If 12 men earn 21 guineas in 7 days of $10\frac{1}{2}$ hours each, in how many days will 10 men earn £27 working 9 hours daily?

(20.) Reduce $\dfrac{47\frac{11}{15}}{238\frac{2}{3}}$ and $\dfrac{11\frac{1}{9}}{14\frac{2}{7}}$ to decimal fractions.

(21.) Find the value of $(3\frac{3}{4}+2\frac{5}{8}\sim 4\frac{1}{16})\div(3\frac{1}{12}\times 2\frac{2}{5}\div 2\frac{1}{2})$.

(22.) If 16 horses eat 30 bushels of oats in 8 days, in what time will 20 horses eat 30 bushels?

(23.) Find the price of 5805 things at £5, 18*s.* $10\frac{1}{2}$*d.* each.

(24.) Make out the cost of mowing a meadow containing 29 ac. 2 roods 35 poles at 3*s*. 6*d*. per acre.

(25.) On what income is £5, 12*s*. 6*d*. paid as tax when the income-tax is threepence in the £?

(26.) In my purse there are 33 coins, shillings and sixpences only; they amount to £1, 5*s*. 6*d*. How many of each are there?

(27.) The sums invested by 2 partners are £3000 and £5500; they gain £1275 in 9 mos. What is the share of each and what has been the rate of gain °/ₒ per annum?

(28.) A man who has lost $\frac{1}{2}$ of $\dfrac{\frac{1}{5}}{\frac{1}{4} \sim \frac{1}{10}}$ of his capital has £3500 remaining. What sum did he lose?

(29.) Simplify $(2\frac{1}{2} + 1\frac{2}{4} \sim 3\frac{2}{3}) \times \left(\frac{1}{2} \text{ of } \dfrac{2\frac{1}{4}}{4\frac{1}{2}}\right)$.

(30.) What is the simple interest of £2187, 10*s*. for 219 days at $4\frac{1}{4}$ °/ₒ?

(31.) A person left £100 per annum for ever to a school in his parish; what sum must have been invested to purchase this annuity in $3\frac{1}{2}$ per cents, the stock being at $93\frac{1}{3}$?

(32.) If $17\frac{1}{2}$ yds. of blue serge, 54 in. wide, cost £3, 18*s*. 9*d*., what ought to be the cost of 30 yds. of the same quality but only 40 in. wide?

(33.) If 1 cwt. of cheese cost £3, 10*s*., what will be the cost of 2 qrs. 15 lbs.?

(34.) Reduce to a simple form $\dfrac{2\frac{1}{5} \times \frac{13}{23}}{\frac{3}{7} \times 1\frac{2}{17}} \div \dfrac{1\frac{4}{5} \times \frac{11}{19}}{\frac{3}{13} \times 1\frac{6}{17}}$

(35.) Explain the process for finding the G.C.M. of two quantities and find the G.C.M. of 185955 and 76153.

(36.) Divide £31994, 14*s*. $11\frac{1}{4}$*d*. by 63, and explain each step of the process.

(37.) Find by Practice the value of 2528 articles at £3, 19*s*. $4\frac{1}{2}$*d*. each.

(38.) A dealer bought £1 worth of steel-pens at 1*s*. 4*d*. per box, each containing one gross, and retailed them at $2\frac{1}{2}$*d*. per dozen; what did he gain on his outlay?

(39.) If the cost of building a wall 135 yds. 2 ft. long, and 1 ft. 9 in. thick, be £17, 16*s*. $1\frac{1}{2}$*d*., what would be the cost of building a wall of the same height, 86 yds. 1 ft. long, and 1 ft. 10 in. thick?

(40.) Simplify $\dfrac{1\frac{2}{7}+2\frac{2}{5}}{6\frac{1}{2}+3\frac{1}{3}}\times\dfrac{2\frac{1}{2}+6\frac{1}{3}}{3\frac{4}{5}\sim 2\frac{2}{7}}$.

(41.) How much money must be invested in the 3 per cent consols at $92\frac{1}{8}$ to bring in an income of £153?

(42.) A can do a piece of work in $2\frac{1}{2}$ days, B can do it in 3 days, C can do it in $3\frac{3}{4}$ days; how long will they be about it all working together?

(43.) A wall that is to be built 27 ft. high was raised 9 ft. by 12 men in 6 days, how many men must be employed to finish the wall in 4 days at the same rate of working?

(44.) At what rate per cent simple interest will £765, 12*s*. 6*d*. amount to £878, 3*s*. $5\frac{1}{4}$*d*. in 4 yrs. 73 dys.?

(45.) Find the cost of paper for a room 11 metres 7 decimetres long, 5 metres 8 decimetres wide, and 4 metres 2 decimetres high, at the rate of 1 franc 50 centimes per piece, being 10 metres long and 7 decimetres 5 centimetres wide.

(46.) A certain quantity of work can be done in $4\frac{1}{2}$ days by 6 men, 9 women, or 12 boys; how long would the same work occupy 4 men, 6 women, and 8 boys?

(47.) If $3\frac{1}{4}$ yards of silk cost £1, 10*s*. $7\frac{1}{4}$*d*., how many yards may be bought for £56, 10*s*.?

(48.) A printing-machine turns out 3500 sheets per hour; if its speed be decreased in the ratio of 7 to 4, how many sheets may be printed in a day of 12 hours?

(49.) At what rate per annum (simple interest) will £1225 amount to £1417, 18*s*. 9*d*. in 3 years?

(50.) Add together $\frac{1}{20}$, $3\frac{1}{6}$, $4\frac{2}{9}$, and $\frac{5}{18}$.

(51.) Find the difference between $13\frac{7}{13}$ and $20\frac{1}{5}$.

(52.) Multiply together $6\frac{3}{5}$, $2\frac{1}{19}$, $\frac{5}{21}$, and $\frac{7}{13}$.

(53.) Divide $2\frac{3}{11}$ by $1\frac{1}{4}$.

(54.) Multiply 48·725 by ·00396.

(55.) Divide ·073776 by ·024.

(56.) Divide 9·04878 by 386·7.

(57.) Express 2*s.* 4*d.* as the decimal of a guinea.

(58.) Find the present value of £1336, 11*s.* 3*d.* due at the end of $3\frac{1}{2}$ years, at 5 per cent.

(59.) By disposing of goods for £364 a man loses 9 per cent; what should have been the selling price in order that a profit of 7 per cent might have been made?

(60.) Gunpowder is composed of 33 parts of nitre, 7 of charcoal, 5 of sulphur; what weight of each of these components is contained in a ton of gunpowder?

(61.) Find the simple interest on £885, 15*s.*, at $5\frac{1}{3}$ °/ₒ for $2\frac{1}{2}$ years.

(62.) If the 4*d.* loaf weigh 24 oz. when wheat is at 50*s.* per qr., what is the price of wheat when the 6*d.* loaf weighs 30 oz.?

(63.) Add together $\frac{1}{30}$, $3\frac{1}{6}$, $4\frac{2}{9}$, and $\frac{2}{15}$.

(64.) Find the square root of $154751\frac{77}{169}$ and the cube root of 7311891877729.

(65.) Divide £354, 14*s.* $1\frac{1}{2}$*d.* amongst 4 persons in the proportion of the fractions $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$.

(66.) Find the income of a person who pays £15, 10*s.* income-tax at 3*d.* in the £.

(67.) By selling an article for £82, a gain of 15 °/ₒ was secured. Find cost price.

(68.) Find the least number which is divisible by all the numbers up to 15 inclusive.

(69.) If $1\frac{3}{5}$ yards of cloth are worth $\frac{5}{12}$ bushels of wheat, and 12 yards of cloth cost $4\frac{1}{2}$ dollars, what is the value of 5 quarters of wheat in English money if 1 dollar is equal to 4*s.* 2*d.*?

(70.) At what rate °/ₒ simple interest will £900 amount to £1120, 10*s.* in 7 years?

(71.) If 200 men make an embankment 5 miles long in 25 days of 12 hours each, how many hours per day must 60 men work to raise an embankment 2 miles long in 32 days?

(72.) A watch is sold for £9, 10*s.* at a loss of 5 °/ₒ; what would have been gained or lost had the selling price been £11, 17*s.* 6*d.*?

(73.) At what rate will £450 amount to £523, 10*s*. in 1 yr. 8 months?

(74.) In what time will £750 yield £375 as interest at 5 °/₀?

(75.) What principal will amount to £900 in 4 years at $6\frac{1}{4}$ °/₀?

(76.) Add together $\frac{13}{14}$, $1\frac{17}{18}$, $\frac{3}{4}$, and $2\frac{11}{12}$.

(77.) After paying income-tax at 5*d*. in the pound I have £576, 6*s*. 8*d*. What is my gross income?

(78.) What will it cost to paint the 4 walls of a room at 8*d*. per square yard, the dimensions being—length, 18 ft. $6\frac{3}{4}$ in.; breadth, 16 ft. $5\frac{1}{4}$ in.; and height, 12 ft.?

(79.) If 2 horses plough 7 acres in a day, how many will plough 161 acres in $11\frac{1}{2}$ days?

(80.) A man's daily pension is 5*s*. $5\frac{3}{4}$*d*.; what is his *yearly* income?

(81.) Simplify $\frac{1}{4}\left(\dfrac{4\frac{7}{9} \text{ of } 6\frac{2}{3}}{7\frac{26}{27}}\right) \times \dfrac{3\frac{2}{5} \sim 3\frac{1}{6}}{3\frac{3}{5} + 2\frac{1}{6}}$ of £182, 7*s*. 5*d*.

(82.) Simplify $2 \times \dfrac{\frac{29}{20} \sim 1\frac{19}{45}}{131 \sim \dfrac{943}{7\frac{1}{5}}} \sim 1\frac{1}{207}$ of $5\frac{11}{13}$ of $10\frac{7}{20}$ of $\frac{5}{19}$ of $\frac{1}{16}$.

(83.) Find the G.C.M. of 169037 and 66429, and L.C.M. of 44, 48, 52, 96.

(84.) A tank whose floor and walls are $1\frac{1}{2}$ in. thick is 5 ft. 3 in. long, 3 ft. 7 in. wide, and 2 ft. $5\frac{1}{2}$ in. high. What is its internal surface, and what will be the cost of painting it at 4*d*. per square foot?

(85.) Add together $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, and $\frac{1}{6}$. Find the value of $(4\frac{2}{5} + \frac{7}{2})$ of $(\frac{2}{7} + 1)$.

(86.) If 32 horses eat 96 bushels of corn in 21 days, for how many days will 66 bushels last 7 horses?

(87.) If 3 ducks are worth 4 chickens, and 3 geese are worth 10 ducks; find the value of a goose, a pair of chickens being worth 4*s*. 6*d*.

(88.) I invest £1365 in the 3 per cents at 91, and sell out £1000 worth of stock when they have risen to $93\frac{1}{2}$ and the remainder when they have fallen to 85. How much do I gain or lose by the transaction?

(89.) Divide 570021 by 77 by short division, explaining how remainder is obtained.

(90.) If 7 oxen eat 3 tons of hay in a month, how long will it take 49 sheep to eat 35 tons; an ox consuming 3 times as much as a sheep?

(91.) Find by Practice the rent of 279 acres 3 roods 36 poles at £2, 11*s.* 8*d.* per acre.

(92.) What principal will amount to £699, 13*s.* 2·4*d.* in 2 yrs., compound interest, calculating 4 % for first year and $3\frac{1}{2}$ % for the second?

(93.) Find G.C.M. of 2793 and 7980; and the L.C.M. of 16, 90, 91, 280, 455.

(94.) Simplify $\dfrac{8\frac{3}{5} \sim 7\frac{3}{4} + 5\frac{2}{3} \sim 4\frac{1}{2}}{13 \sim 11\frac{9}{10} + 10\frac{7}{9} \sim 9\frac{17}{20}}$ of $\frac{2}{11}$ of 365.

(95.) A cistern is filled by one pipe in 48 minutes, by a second in an hour, and by the third in half an hour. In what time will all 3 fill it if open together?

(96.) Divide 4·068 by ·0018, and simplify $\dfrac{4\frac{2}{3} \sim 3\frac{1}{2}}{4\frac{2}{3} + 3\frac{1}{2}}$ and $\frac{2}{3}\left(\frac{2}{3} \text{ of } \dfrac{2\frac{1}{4} + 1\frac{1}{2}}{3\frac{1}{2} \sim 1} + \frac{1}{2}\right)$.

(97.) Find the value of $\dfrac{\sqrt{2}+1}{\sqrt{2} \sim 1} + \dfrac{\sqrt{2} \sim 1}{\sqrt{2}+1}$.

(98.) Find the value of 7 cwts. 3 qrs. 21 lbs. at £9, 13*s.* 4*d.* per cwt.

(99.) What will be cost of painting the 4 walls of a room 32 ft. 4 in. long, 15 ft. 8 in. broad, and 11 ft. 6 in. high, at 3*s.* per square foot?

(100.) I invest £3580 in 3 per cents at $89\frac{1}{2}$; what is my income (less income-tax of 6*d.* in the £)?

(101.) Find value of $\dfrac{15\frac{3}{4} \sim \frac{14}{3} \times 1\frac{5}{6}}{\frac{1}{5} \times 23\frac{1}{3} + \frac{91}{36}}$.

(102.) A contributes £50, B £60, and C £80 to a business. B takes out his money after 10 mos.; A and C continued the business for 6 mos. longer, when the profits were £355. Find each partner's share in this gain.

(103.) A tank holds 5360 gallons of water. Find weight of water in tons; a gallon weighing 10 lbs.

(104.) Divide 345678910457 by 4073.

(105.) What will 473 articles cost at £4, 7*s.* $3\frac{1}{2}$*d.* each, and determine the total gain, supposing the seller bought them at £3, 19*s.* $2\frac{3}{4}$*d.* each, but incurred an expense of £29, 3*s.* $4\frac{1}{2}$*d.* on account of them?

(106.) Add together $\frac{4}{5}+\frac{5}{16}+\frac{7}{20}+\frac{8}{25}+\frac{19}{400}$, and simplify $\dfrac{4\frac{1}{5}+(\frac{2}{3}\text{ of }\frac{7}{16})}{(\frac{5}{8}\text{ of }\frac{7}{6})\sim\frac{3}{5}}$.

(107.) Add $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$, $\frac{6}{7}$, $\frac{7}{8}$, $\frac{8}{9}$, $\frac{9}{10}$, and divide their sum by $\frac{8}{4}$, giving answer in lowest terms.

(108.) Find the L.C.M. of 28, 45, 54, 63, and reduce $\dfrac{10393}{14079}$ to its lowest terms.

(109.) Reduce to its simplest form

$$\frac{2\frac{7}{8}+\frac{3}{8}\text{ of }9\frac{3}{5}+3\frac{11}{12}}{117\frac{13}{40}\sim 106\frac{14}{15}}\times\frac{1\frac{2}{3}\text{ of }\frac{3}{5}\text{ of }21}{23}\text{ of }\frac{3\frac{5}{6}}{5\frac{3}{12}}.$$

(110.) Express a mile in metres, a metre being equal to 39·371 inches.

(111.) A has 7 shares, B 5, C 3, and D 1 share. The profits are £1205. Find each partner's share.

(112.) If on a straight road stones be placed at intervals of 50 feet, and a measuring tape of 15 yards be used, how often will the end of the tape coincide with a stone in a distance of 1 mile?

(113.) Multiply 1·025 by 25·255, and divide the result by ·0255.

(114.) At a railway station 16257 tickets were sold, $\frac{1}{3}$ of which were 9*d.* each and the rest 4*d.* Find gross amount received.

(115.) I bought a number of sheep for £97, 10*s.* at £1, 17*s.* 6*d.* a head; some of them died. I then sold the rest at £2, 4*s.* 6*d.*, and gained on the whole £2, 12*s.* 6*d.* How many died?

(116.) Find by Practice the value of 860 cwts. at £3, 3*s.* $6\frac{1}{2}$*d.* per cwt.

(117.) Find the G.C.M. of 189, 252, 441, and 2205.

(118.) Obtain the L.C.M. of 2, 5, 33, and 1496.

(119.) Simplify $\dfrac{\frac{2}{3}\text{ of }\frac{5}{7}\text{ of }\frac{35}{9}}{\frac{1}{7}\text{ of }\frac{2}{3}\text{ of }\frac{84}{81}}$ and add it incrementally to the sum of $10\frac{3}{4}$, $3\frac{9}{10}$, and $7\frac{24}{25}$.

(120.) Add together $12\frac{4}{5}$, $8\frac{7}{24}$, $5\frac{37}{60}$, and find the difference between $112\frac{2}{121}$ and $75\frac{13}{110}$.

(121.) Which is greater, $1\frac{2}{3} \times 2\frac{5}{8}$ or $\cdot 018 \times 21\cdot 6$?

(122.) Add together $\frac{3}{5}$, $\frac{9}{10}$, $\frac{3}{14}$, and $\frac{8}{21}$.

(123.) Simplify $\dfrac{7\frac{3}{4} \sim 6\frac{13}{16} + \frac{5}{24}}{3\frac{5}{12} \sim 2\frac{3}{16} + 5\frac{1}{48}}$.

(124.) Multiply 57·064 by ·00625, and divide 365·248 by ·0125.

(125.) A man spends £10, 11*s*. 9*d*. a week; how much does he spend in a leap year?

(126.) Calculate the cost of 16 cwts. 3 qrs. 13 lbs. at £32, 13*s*. 4*d*. per ton.

(127.) Find the G.C.M. of 104811, 48825, and 68789.

(128.) If 16 men mow 2 acres in 13 hrs. 20 min., how many men will mow 3 acres in 5 hrs. 20 min.?

(129.) If I buy £100 stock, paying 7 °/o for 119, what price must I sell it for at the end of the year so as not to lose, if money be worth 5 °/o?

(130.) Add $\frac{1}{12}$, $\frac{17}{28}$, $\frac{5}{8}$, and $\frac{9}{16}$, and multiply the sum by $1\frac{3}{5}$.

(131.) A clerk puts by every week three-tenths of his week's salary, but at the end of the year spends two-thirds of his savings; how long will he take to save a full year's salary?

(132.) Find the cost of carpeting a floor 120 ft. by 80 ft. with carpet $1\frac{1}{2}$ yards wide at 4*s*. 6*d*. per yard.

(133.) Three men subscribe £4600. A gives £400 more than B, who gives £300 more than C. If their gain be £345, find what each contributes and what each is entitled to of the profits.

(134.) What is the rating on £316 at 2*s*. $8\frac{1}{2}$*d*. in the £?

(135.) If 120 men do a work in 35 days, how soon will 150 men do it?

(136.) Find by Practice the value of 7865 bushels at $10\frac{3}{4}$*d*. per bushel; and of 102 cwts. 3 qrs. 8 lbs. at £1, 19*s*. 8*d*. per cwt.

(137.) Find the interest of £3756 for $3\frac{3}{4}$ years at $4\frac{1}{2}$ °/o.

(138.) Add together $\frac{3}{5}$, $\frac{9}{25}$, $\frac{27}{125}$, $\frac{81}{625}$, and add $\frac{2}{3}$ of $\frac{5}{8}$ of $17\frac{11}{20}$ to $\frac{3}{5}$ of $\frac{4}{11}$ of $17\frac{2}{7}$.

(139.) What is the difference between £24, 5*s*. $4\frac{3}{4}$*d*. × $\frac{5}{23}$ and £39, 0*s*. $10\frac{1}{4}$*d*. ÷ $4\frac{5}{8}$?

(140.) If tea which is sold for 2*s*. 8*d*. per lb. in town costs 3*s*. 6*d*. per lb. in the country, how many pounds must be bought in town to defray expense of railway ticket, 4*s*. 2*d*., and clear half a crown?

(141.) Reduce 182214 inches to miles, and 315 half-guineas to half-crowns.

(142.) Find the sum of $\frac{3}{5}$, $\frac{4}{7}$, $\frac{11}{15}$, $\frac{5}{21}$, and 8; and the product of $\frac{5\frac{1}{4}}{2\frac{1}{2}}$, $\frac{1\frac{7}{8}}{\frac{3}{4}}$, and $\frac{\frac{2}{3}}{3\frac{1}{2}}$.

(143.) If 12 men do a work in 18 days of 10 hours each, how many hours a day must they work to do it in 15 days?

(144.) If with a capital of £1500 I gain £140 in 8 months, in what time with a capital of £546 should I gain £45, 10*s*.?

(145.) Find the values of £·5346, ·458 cwt., and $\cdot 97291\dot{6}$ mile.

(146.) If I buy £1400 stock in the 3 per cents at $92\frac{5}{8}$, paying brokerage $\frac{1}{8}$, what does it cost me? and what will the annual interest on my outlay be?

(147.) How many persons will receive each 4*s*. 4*d*. out of a fund of £537, 11*s*.?

(148.) Five-thirteenths of an estate cost £3547, 5*s*. $7\frac{1}{2}$*d*.; what is the value of the whole?

(149.) Obtain the continued product of 35·7, 3·57, and ·357, dividing the result by ·0357.

(150.) What fraction of 15*s*. is $1\frac{1}{8}$ of £2 ~ $\frac{2}{7}$ of 6 guineas?

(151.) What is the value of $\cdot 2\dot{7}$ of $1\frac{1}{5}$ of £19, 17*s*. $5\frac{1}{2}$*d*., and of

$$\cdot 175 + \frac{\cdot 2}{\cdot\dot{3}} \sim \frac{1}{2 \text{ of } 1\frac{9}{11}}\ ?$$

(152.) The present value of £50, 15*s*. $5\frac{3}{5}$*d*., due in 2 years and 8 months, is £45, 6*s*. 8*d*.; find the rate °/ₒ, calculating simple interest.

(153.) What interest per cent is derived from investing money in the 3 per cents at 84?

(154.) A ship costing £9600 is wrecked; what did a person lose who possessed $\frac{3}{16}$ of it, the ship being insured for £95 °/ₒ of its real value?

(155.) Find the square root of $5\cdot\dot{4}$ to 4 figures.

(156.) A contributed £600 for 5 months to a business an received $\frac{2}{5}$ths of the whole profit. B contributed £500 How long was B's money in the business?

(157.) A dealer mixes 42 lbs. of tea, costing him 2*s.* $1\frac{1}{2}$*d.* per lb., with 12 lbs. at 2*s.* $5\frac{1}{2}$*d.* per lb.; at what price per lb. must he sell the mixture to gain £1, 5*s.* 3*d.* by the sale?

(158.) Find by Practice the weight of 650 coins, each weighing 5 dwt. 9 grs.

(159.) In what time will £333, 6*s.* 8*d.* amount to £400, 16*s.* 8*d.* at $4\frac{1}{2}$ °/₀ simple interest?

(160.) Find value of 2·45 of 5 guineas, and reduce 3*s.* 4*d.* to the decimal of £1, 6*s.* 8*d.*

(161.) If the fare of 2 persons for 32 miles be 8*s.*, what will be the fare of 3 persons for 20 miles?

(162.) Simplify $(8\frac{5}{12} + 6\frac{3}{8}) \sim (5\frac{4}{5} + 7\frac{11}{15})$, $\dfrac{5\frac{2}{13} \sim 3\frac{4}{5}}{5\frac{2}{13} \times 3\frac{4}{5} \sim 1}$, and also

$$\cfrac{1}{7 \sim \cfrac{1}{7 + \frac{1}{7}}}.$$

(163.) A walks $3\frac{1}{2}$ miles an hour and B 4 miles. They walk towards each other from two places 10 miles apart. When they meet what distance will each have walked?

(164.) Divide 7·852 by ·325; find the difference between $2{\cdot}03\dot{7}$ and $5{\cdot}1\dot{2}\dot{3}$; and multiply $8{\cdot}1\dot{7}$ by $1{\cdot}\dot{4}\dot{5}$.

(165.) Express $17\frac{1}{2}$ miles in kilometres, taking a kilometre as equal to 1093·6 yards.

(166.) What number of tons of stone will be required to build a breakwater 25 ft. broad at the top and 75 ft. at the bottom, with a mean height of 20 ft., length 2240 ft., the stone weighing 180 lbs. per cubic foot?

(167.) Find the difference between £8, 7 fl. 4 cents 16 mills and £12, 4 fl. 24 cents 11 mills, and express the result in £, *s.* *d.*

(168.) At what rate °/₀ will £540 amount to £580, 10*s.* in $2\frac{1}{2}$ yrs.?

(169.) My income from the 3 per cents bought in at $90\frac{5}{8}$ is £165, 12*s.* 6*d.* How much did I invest?

(170.) Copper ore is worth £13, 19*s.* 3*d.* per ton, and yields $14\frac{7}{8}$ °/₀ pure copper; find the price of the copper per ton.

1.) Find the least number exactly divisible by 156, 185, 224, and 240.

2.) Reduce 2·0428125 to a vulgar fraction in lowest terms, also reduce $(\frac{11}{15} + 5\frac{11}{125} + 4\frac{5}{8}) \sim (3\frac{2}{3} + 1\frac{16}{25} + 2\frac{7}{100})$ to a fraction in lowest terms, and then give its equivalent repeating decimal.

3.) Multiply ·00307 by ·000702; add to the product ·00022534486 and divide the sum by ·091.

4.) A French square metre contains 10·7643 English square feet; find, to 2 places of decimals, the number of feet in the length of a metre.

5.) On a railway 1209¾ miles long the receipts in one week were £96168, 9*s*., while in the corresponding week of the preceding year the receipts were £87055. Calculate the increase in the average receipts per mile per week.

76.) In French silver money 1 franc (or 100 centimes) is worth 9½*d*. English when silver is at 5*s*. the ounce. What sum of French money is worth £262, 12*s*. 8*d*. when silver is at 5*s*. 1½*d*. the ounce?

77.) Reduce to vulgar fractions in lowest terms $(2\frac{7}{24} + 5\frac{7}{32}) \sim (1\frac{11}{18} + \frac{11}{16})$; also 8·95625.

78.) What sum would amount to £149, 4*s*. 7*d*. in 9 years at 5 °/ₒ per annum simple interest?

79.) I bought goods for £665, gaining 5 °/ₒ by selling them to B, who on his part lost 5 °/ₒ by reselling them to C. What did C pay for them?

80.) Find G.C.M. of 100110 and 31866; also L.C.M. of 16, 18, 24, 32.

81.) A man sells 24·65 yds. of cloth for £36, 19*s*. 6*d*., gaining thereby the cost of 4·93 yds. What was the money value of his gain and the rate of gain °/ₒ?

82.) If 3·75 cwts. be carried $51\cdot\dot{6}$ miles for £·875, what weight should be carried 75 miles for £2·625?

3.) In what time will a sum of money double itself at 4⅙ °/ₒ simple interest?

4.) I transfer stock from the 5 per cents at 115 to other funds at 126½ and find my income unaltered by the change. What rate did the new stock pay?

(185.) A, B, and C's shares are as $\frac{1}{2}$ to $\frac{1}{3}$ to $\frac{1}{4}$. A withdraws h his capital at the end of 4 months, and after 8 mont £1056 profits are divided; what is each partne share?

(186.) At what price must the $4\frac{1}{2}$ per cents be to produce t same income as the 5 per cents at £115? Find t income from an investment of £2346 in either stock.

(187.) Find the L.C.M. of 1932 and 1679.

(188.) Express in furlongs, poles, and yards $\frac{1519}{3080}$ mile.

(189.) Find the value of $\frac{4}{15} + 2\frac{1}{6} \sim \frac{3}{7}$.

(190.) If 12 men earn £29, 14*s.*, how many men will ear £81, 13*s.* 6*d.* in the same time?

(191.) If 1 metre = 39·3708 inches, reduce 4 yds. $7\frac{1}{2}$ in. to th decimal of a metre.

(192.) A and B have 14*s.* 6*d.* between them; A and C hav 11*s.* 6*d.*, and B and C have 13*s.* 4*d.*; how much ha each?

(193.) A tank is 18 ft. long by 16 ft. broad; how deep must i be to hold as much as another 20 ft. long, 15 ft. broad, and 27 ft. deep?

(194.) Find the simple interest and amount of £416, 2*s.* 6*d.*, from April 2nd to May 9th at $4\frac{1}{2}$ $^{\circ}/_{\circ}$.

(195.) I rent a 10-acre field at £4 an acre; paying for farming expenses £17, 10*s.*, for seed at the rate of £6, 15*s.* an acre. The crops yield me £140 gross. What is my net profit, and at what rate $^{\circ}/_{\circ}$ is it?

(196.) Resolve 94248 and 105336 into their prime factors. Find their G.C.M., also their L.C.M., and reduce the fraction $\frac{94248}{105336}$ to its lowest terms.

(197.) Find the value of ($\cdot1785$ of 2*s.* + $3\cdot2\dot{5}\dot{1}$ of 11*d.*) ~ ($\cdot0\dot{4}$ of £$2\frac{1}{2}$ + $\cdot115\dot{3}$*s.*).

(198.) Express $\left(\frac{1}{12} + \frac{1}{15} + \frac{1}{24} \sim \frac{1}{27} \text{ of } 2\frac{1}{40}\right)$ of a guinea as a decimal of £2, 9*s.*

(199.) The simple interest of a certain sum at $4\frac{1}{2}$ $^{\circ}/_{\circ}$ for 2 yrs 4 mos. is £63 more than the simple interest of sam sum at 5 $^{\circ}/_{\circ}$ for one yr. 9 mos. Find the principal.

(200.) Add together $5\frac{1}{3}$, $4\frac{5}{8}$, $\frac{7}{12}$, $1\frac{5}{9}$, $\frac{1}{36}$.

Raise 1·035 to the 8th power retaining only 4 decimal places, and extract the square root of ·3 to four places.

Express 14*s.* 2*d.*, 13*s.* 7*d.*, and 2*s.* $4\frac{3}{4}$*d.* as decimals of £1. Add the results and convert to £, *s.* *d.*

What is a perpetual annuity of £150 worth, reckoning interest at 4 °/ₒ?

Express as decimals $\frac{119}{1750}$ and $\frac{99}{385}$.

Find the sum and difference of ·040404 and seventy-six thousand four hundred and sixteen millionths. Multiply the results, and divide the product by ·3001.

Find the rent of 145 ac. 3 ro. 16 pls. at £3, 7*s.* 6*d.* per acre.

Simplify $(4\frac{3}{16} + 1\frac{1}{4} + \frac{1}{14}) \sim (\frac{31}{56} + \frac{23}{112})$.

Reduce to square poles, &c., 100000 square inches.

How much coffee at 1*s.* $10\frac{1}{2}$*d.* per lb. must be given in exchange for 75 lbs. of tea at 2*s.* 6*d.* per lb.?

Find the value of $\frac{\cdot025 \times \cdot2\dot{5}}{\cdot00\dot{2}\dot{5}}$, and reduce 2*s.* $3\frac{1}{2}$*d.* to the decimal of £1, 2*s.* 6*d.*

A room is $12\frac{1}{2}$ ft. broad and $22\frac{1}{2}$ ft. long; what will it cost to cover it with carpet $\frac{3}{4}$ yd. wide at 4*s.* 6*d.* a running yard?

Find value of $\frac{\cdot00125}{\cdot18}$, and the square root of ·0531118116.

Reduce £3, 11*s.* $9\frac{3}{4}$*d.* to decimal of £1, and find value of ·1825 of £2, 6*s.* 8*d.*

Add together $1\frac{7}{8}$, $3\frac{1}{5}$, $\frac{3}{20}$, $2\frac{3}{16}$, and find value of $1\frac{7}{8}$ of $3\frac{1}{5}$ of $\frac{3}{20}$ of $2\frac{3}{16}$ of 10*s.* 8*d.*

If 24 men can dig $139\frac{3}{4}$ yds. of a trench in $2\frac{1}{2}$ days, how many yards can 90 men dig in $1\frac{3}{4}$ days?

Reduce the fraction $\frac{29505}{37092}$ to its lowest terms. Find G.C.M. of 238, 374 and 442, also find L.C.M. of 7, 14, 28, 42, 35.

Multiply ·052375 by ·88; also divide ·0042003 by 1·17. Find the difference of the 2 results, and reduce it to a vulgar fraction in its lowest terms.

(218.) The proceeds of the sale of 3½ per cents at 93⅛ amounted to £6844, 13*s.* 9*d.* Find the amount of the stock and the clear annual income derived from it, deducting income-tax at 5*d.* in the £.

(219.) Simplify $\frac{50\frac{1}{12}}{19\frac{2}{11}} \times \frac{2\frac{3}{7} + 1\frac{7}{8} \sim 1\frac{5}{28}}{3\frac{13}{21} + \frac{11}{24} \sim \frac{1}{2}}$.

(220.) Find first 2 significant figures (not more) of the quotient of ·660375 divided by 23·54.

(221.) Find the sum, difference, product, and quotient of $\cdot 78\dot{9}6\dot{2}$ and $\cdot\dot{3}$.

(222.) Find value of $8\cdot 31\dot{6}$ oz. + $\cdot\dot{2}8571\dot{4}$ dwt. ~ $\cdot 30\dot{3}\dot{7}$ lb. troy.

(223.) A, B, and C run a quarter of a mile race. A has 3 yds. start and B 2. C gains 1 foot in 40 throughout on A, B gains 2 ft. in 25 yds. on A for the first 200 yds., after that loses 1 ft. in 20 yds. What is the result of the race?

(224.) If nine men dig a trench 3 ft. deep, 4½ ft. wide, and 120 yds. long; how many men will dig a trench 5 ft. deep, 4 ft. wide, and 180 yds. long in the same time?

(225.) What sum will produce £28, 17*s.* 6*d.* simple interest in the 3½ per cents for six years?

(226.) Divide 174·45 by ·0375; 17·445 by 37·5; and $6\cdot\dot{3}\dot{2}$ by $\cdot 1\dot{7}$ to 4 places.

(227.) Convert without division the following fractions into circulating decimals: $\frac{6322}{9990}$ and $\frac{826131}{999900}$.

(228.) What is the cost of papering a room 14 ft. 6 in. long, 10 ft. 6 in. broad, and 8 ft. high, with paper 2 ft. wide at 1½*d.* per yd.?

(229.) Find the discount on a bill for £498, 18*s.* due in 10½ mos. discounted at 4½ %.

(230.) Divide 673·5 by 1·25; ·06735 by ·125; and $17\cdot\dot{2}\dot{5}$ by $7\cdot\dot{6}$ correct to 4 places.

(231.) Convert without division into circulating decimals $\frac{5271}{9990}$ and $\frac{123645}{999900}$.

(232.) Find the value of $\frac{4}{\sqrt{17} \sim 3}$ to 4 places exact.

(233.) Show that the same days of the month will fall on the same days of the week in March and November in any one year.

) Find present worth of a bill for £279, 2*s.* 6*d.* due in 4½ mos. at 4 %.

) Resolve 11781 into its prime factors. Find G.C.M. and L.C.M. of 5083, 14053, and 10387.

) Multiply 34·56 by ·006543, and divide the product by ·0727.

.) Simplify $\{(6\frac{5}{6}+9\frac{7}{12})\sim(5\frac{5}{8}+8\frac{1}{3}+\frac{9}{10})\}\div(1+\frac{1}{2}+\frac{1}{20}+\frac{1}{120})$.

.) Find value of $\frac{5}{6}$ of ·0375 of £1 + ·3125 of 10*s.* + $\frac{4}{7}$ of $\cdot 5\dot{3}\dot{9}$ of 1*s.* 10½*d.*

.) Find value of $\frac{5}{6}$ of ·075 of £1 + $\frac{4}{7}$ of $\cdot 5\dot{3}\dot{9}$ of £1, 0*s.* 7½*d.* + $\frac{1}{\cdot 2\dot{3}}$ of 10½*d.*

).) Simplify $\frac{(2\frac{1}{6}+8\frac{5}{24}+\frac{4}{5})\sim(3\frac{7}{8}+5\frac{2}{3})}{(1+\frac{1}{30})\sim(\frac{1}{3}+\frac{1}{120})}$.

1.) Resolve 19019 into its prime factors. Find H.C.F. and L.C.M. of 6916, 10686, and 14729.

2.) Add $\frac{1}{2}+\frac{2}{3}+\frac{3}{4}+\frac{5}{6}+\frac{7}{9}+\frac{11}{12}$.

3.) H.C.F. of 2526 and 2947.

4.) If ·5 of £1 buy ·4 of a gallon, how much will 6*s.* 3*d.* buy?

5.) Find cost of carpeting a room 21 ft. by 30 ft. with carpet ½ yard wide at 4*s.* 6*d.* per running yard.

6.) If 12 men do a work in 15 days of 10 hours, how long will 10 men take to do it working 9 hours daily?

7.) Multiply ($\frac{1}{2}$ of $\frac{2}{3}$ of $\frac{3}{4}$) by ($\frac{1}{3}$ of $1\frac{2}{7}$ of $1\frac{1}{3}$ of $1\frac{2}{5}$), and divide the result by ($\frac{1}{3}$ of $\frac{1}{4}$ of $2\frac{2}{5}$).

8.) If 5000 bricks 4 in. thick are required for a wall 125 ft. long, how many bricks 5 in. thick will be required for a wall 80 ft. long?

9.) Find the value of ·723 of £8, 6*s.* 8*d.*, and reduce ·64 of £1 to the decimal of 1*s.* 3*d.*

0.) A bankrupt paid 5*s.* 11*d.* in the pound, his assets being £71. What did he owe?

1.) A ward is 50 ft. long, 20 ft. wide, and 15 ft. high; how many patients will it accommodate, giving 600 cub. feet to each?

:) Express $\cdot 4\dot{6}\dot{6}$ as a vulgar fraction, and multiply $3\cdot 5\dot{9}$ by $4\cdot\dot{7}$.

(253.) H.C.F. of 43365 and 44688.

(254.) If 100 men dig a trench 200 yds. long, 3 yds. wide, an 2 yds. deep in 6 days of 10 hours, in how many da of 8 hours can 180 men dig a trench 360 yds. lon 4 yds. wide, and 3 yds. deep?

(255.) A train 88 yards long overtook a man walking along th line at the rate of 4 miles per hour, and passed hi completely in 10 seconds, it afterwards overtook an other man and passed him in 9 seconds; at what rat per hour was the second man walking?

(256.) If 5 men build a wall 5 ft. high and 100 yds. long in days, how long will it take 7 men to build a wall 20 yds. long and $3\frac{1}{2}$ ft. high?

(257.) Simplify $\dfrac{(4\frac{3}{7}+6\div4\frac{2}{3})\sim\frac{5}{9}\text{ of }4\frac{2}{13}}{(18\frac{90}{91}\div8)\sim\frac{2}{3}\text{ of }1\frac{6}{7}}$.

(258.) Multiply $\dfrac{5{\cdot}76}{{\cdot}018}$ by $\dfrac{{\cdot}00196}{64}$, and find difference betwee $\dfrac{{\cdot}159}{{\cdot}0212}$ and $\dfrac{1851{\cdot}85}{25{\cdot}9}$.

(259.) Add $\frac{9}{13}$ of £9, 6*s*. $10\frac{1}{2}$*d*. to $\cdot3\dot{5}\dot{4}$ of £32, 1*s*. 8*d*., and express result as decimal of £30.

(260.) Find cost of paving a floor 11 yds. 2 ft. long by 9 yds. $2\frac{2}{5}$ ft. broad with tiles 7 inches square, which cost £3, 4*s*. 7*d*. per hundred.

(261.) Find value of $\sqrt{\cdot144}\sim\cdot07\dot{9}\dot{3}$ true to 4 places.

(262.) A sum of £52, 18*s*. is made up of half-sovereigns, half-crowns, and sixpenny pieces, the numbers of these coins being in the proportion of 3, 5, 7; how many are there of each?

(263.) What sum will amount to £353, 12*s*. in 2 yrs. 4 mos., at $4\frac{1}{2}$ °/o simple interest?

(264.) The present value of a bill £169, 19*s*. $4\frac{1}{2}$*d*., due 1 yr. and 3 mos., is £163, 6*s*. 8*d*. What is rate °/o?

(265.) A grocer has a stock of tea which he must sell at 3*s*. $4\frac{1}{2}$*d*. per lb. in order to gain 35 °/o. How much will he gain °/o if he mix it in the proportion of 5 to 2 with inferior tea which cost him 2*s*. 1*d*. per lb., and sells the mixture at the rate of 14 lbs. for £2, 5*s*.?

(266.) Simplify $\dfrac{5\frac{3}{4}+2\frac{2}{35}\div1\frac{11}{25}\sim\frac{3}{7}\text{ of }15\frac{3}{4}}{\frac{3}{4}\text{ of }7\frac{3}{7}\sim5\frac{3}{5}\div3\frac{4}{15}}$.

(267.) I hold certain stock in the 3 per cents; sell out at 96 and invest proceeds in shares at £112 paying $5\frac{1}{2}$ °/₀ on the £100 shares. If my income now be £121 what amount of stock had I originally in the 3 per cents?

(268.) Add together $\frac{3\cdot9}{\cdot104}$ and $\frac{\cdot057}{22\cdot8}$, and multiply $\frac{115}{\cdot0092}$ by $\frac{1451\cdot45}{1160}$.

(269.) Add ·3795 of 18*s*. to $\cdot4\dot{3}6\dot{0}$ of £9, 5*s*., and reduce result to decimal of £5.

(270.) The area of a square field is 3 roods 19 poles $20\frac{1}{4}$ sq. yards. Find the dimensions of a rectangular field of same area whose length exceeds that of the square field by 104 yards.

(271.) If £4 sterling be worth 117 lire in Italian currency, and 23·4 lire be worth 21 francs. Express £26, 3*s*. 4*d*. in francs and centimes (one franc = 20 centimes).

(272.) A, B, and C can do a piece of work together in 5 days; but A strikes after 2 days' work, and B and C finish it in 5 days more; C can do the whole work by himself in 15 days. In what time can A and B do it respectively?

(273.) Add together $\frac{5\cdot7}{1\cdot52}$ and $\frac{\cdot0111}{\cdot74}$, and multiply $\frac{\cdot85}{\cdot0068}$ by $\frac{1151\cdot15}{1610}$.

(274.) Find difference between ·4625 of 16*s*. and $\cdot11\dot{3}\dot{6}$ of £8, 5*s*., and express result as decimal of £3.

(275.) If £5 sterling be worth 127 francs and 20 francs equal 22·5 lire in Italian currency, express £24, 16*s*. 8*d*. in lire and centesimi (1 lire = 100 centesimi).

(276.) By selling tobacco at 1*s*. 3*d*. per lb. a tobacconist gains 35 °/₀. What does his profit amount to on the sale of 4 cwts. 11 lbs.?

(277.) A person invests £3636 in railway shares paying $5\frac{1}{2}$ °/₀, the price of a £100 share being £120. He sells out when the shares are at 136 and invests the proceeds in the Moscow Jaroslav railway 5 °/₀ debentures, the price being £101 per debenture of £100. Find the differenc of the incomes derived from the two investments.

(278.) A can do one-half as much again as B can do in the sam time, and B can do one-third as much again as C Working together they can do a certain piece of worl in 5 days; but if after working 2 days A strikes, hov long will B and C take to finish it?

(279.) Express the difference between $\cdot02\dot{5}\dot{4}$ of £134, 1*s.* 3*d.* an $\frac{13}{15}$ of £5, 3*s.* 1½*d.* as the decimal of £3.

(280.) If the cost of paving a floor 12½ yds. long by 6 yds. 4½ in wide with tiles 7 in. square be £70, 17*s.* 6*d.*, find th price of the tiles per 100.

(281.) A sum of £38, 4*s.* is made up of half-sovereigns, half crowns, and threepenny pieces. There are twice a many half-crowns as half-sovereigns, and the numbe of half-sovereigns bears to the number of threepenn pieces the ratio of 3 to 11. How many are ther of each coin?

(282.) I derive an income of £126, 13*s.* 4*d.* from 3 per cent consols. I sell out at 93 and buy Russian 3½ per cents at 95. What is the difference in my income?

(283.) Find value of $5\cdot4\dot{9}$ of $\cdot\dot{0}4761\dot{9}$ of twenty-five guineas.

(284.) Find cube root of 76440958·784.

(285.) Multiply in all the ways you can 7 ft. 8 in. 7 pts. by 3 ft. 7 in. 11 pts., and express the answer in square inches and fractions.

(286.) Reduce $\frac{\cdot102366}{\cdot141}$ of $22\cdot\dot{2}$ of $\cdot\dot{5}\dot{9}$ of $\cdot2\dot{3}\dot{4}$ to a vulgar fraction in lowest terms.

(287.) Find in 2 different ways the solid content of a block 36 ft. 7 in. long, 7 ft. 11 in. deep, 6 ft. 10 in. wide. Give result in cubic yards, feet, and inches.

(288.) The sides of a quadrilateral field A B C D are as follow: A B, 200 links; B C, 650 links; C D, 905 links; A D, 570 links; and the diagonal AC = 800 links. Find area of field.

(289.) Divide ·00128 by 8·192 to 6 places of decimals, using the contracted form.

(290.) Reduce 10¾ to decimal of 1*s.* 6*d.*

(291.) Find square root of 3915380329 and of $83\frac{193}{529}$.

(292.) Find value of £·778125, also of £·1875.

(293.) Reduce 3 bushels 1 peck to decimal of 1 quarter.

(294.) Find compound interest on £750 for 3 years at 4 °/ₒ.

(295.) Divide 7·73682 by 101·4, and reduce $\cdot 3\dot{6}\dot{3}$ of £2, 1*s.* 3*d.* to decimal of $\cdot\dot{7}\dot{2}$ of £3, 6*s.*

(296.) Find square roots of 1522756 and $9\frac{67}{121}$.

(297.) Find to 3 places value of $(2\sqrt{3}+\sqrt{27}) \sim \frac{1}{2}\sqrt{12}$.

(298.) Find value to 3 places of $\dfrac{\sqrt{5}+\sqrt{3}}{\sqrt{5}\sim\sqrt{3}}$.

(299.) Sea-water contains $2\frac{1}{2}$ °/ₒ of salt. How much sea-water would yield a ton of salt? (Answer in tons.)

(300.) Genuine sovereigns have 9167 parts of pure gold in 10,000; some spurious sovereigns lately offered had only 8138 parts; find actual value of one of these counterfeit coins.

III. ADVANCED ARITHMETIC QUESTIONS.

SET AT CIVIL SERVICE AND OTHER EXAMINATIONS.

(1.) Extract the square root of $109\frac{628}{729}$, and find the side of a cube containing 2048383 cubic inches.

(2.) A train is just 27 minutes in passing through a tunnel the length of which is 11220 metres (a metre = 39·39 in.). Find the speed of the train in miles per hour.

(3.) The water in a leaky reservoir 38 ft. long and 26 ft. wide sinks 1 in. in 12 hrs. A pipe discharging 60 gallons per minute fills the reservoir in 45 hrs. allowing for the leakage. Find to an inch the depth of the reservoir (1 cub. ft. of water = 6·25 galls.).

(4.) I invest £26180 in the 3 per cents at $93\frac{1}{2}$, but shortly after sell out a half at $92\frac{1}{4}$ and with the proceeds buy in the 4 per cents at 97. Find to a penny the difference in my income.

(5.) Find the value of $3\cdot\dot{6}$ of $\cdot\dot{9}5\dot{4}$ of $\cdot 4\dot{2}8571\dot{1}$ of 2*s.* 3*d.*

(6.) Find the cube root of 51478848000.

(7.) A square field contains 3 ac. 2 ro. 7 po. 9¼ yds. Fin length of its side.

(8.) If a sovereign contains 112 grs. of pure gold, and 25 standard gold is minted into 1200 sovereigns, w the proportion of alloy in standard gold?

(9.) A wall 5 ft. high and 1½ bricks thick is built with 1 lion bricks. How many more bricks would be req to add buttresses half a brick thick, 1½ ft. wid 4 ft. high at every fifth yard? A brick being long, 4½ in. wide, and 3 in. thick.

(10.) If the volume of a ton of water be 36 cubic feet, cubic metre of water weighs 1000 kilogrammes, fi ratio (or relation) of a kilo. to a pound (a metre 1·1 yards).

(11.) A man with £4400 for investment buys £1000 st the 3 per cents at 81; £1500 in the 3½ per cents and as much in the 4 per cents at 112 as his rem capital will secure. What interest °/o does he get total investment?

(12.) A prairie fire spreads from a centre at the rate of 80 minute. After lasting for an hour its rate is a ated 5 °/o. How much more surface will it in the 5 minutes following than it did in th minutes preceding the completion of the hour? of circle is in direct ratio to the square of the rad

(13.) A and B run a race of 4 miles. When A has run 2½ B has run 2⅜. In what ratio must B increase his so as to win by 300 yards?

(14.) A lawn 100 yards long and 96 yards wide is to be 4 inches by the earth obtained from a ditch dug the lawn. The ditch being 6 ft. wide, requir depth.

(15.) Which is the better investment, the 3½ per cents at the 4 per cents at 108? If one of these invest yields £50 a year more than the other, what is th tal invested?

(16.) A ship sailing 10 miles per hour is observed to mov a mile in the interval between the flash of a gun on board being seen and the report being hea shore. Sound travelling 1140 ft. per second cal the distance of the ship from the point of observation (light being assumed to be instantaneous in its transmission).

The price of land about London is every year rising 4 °/$_0$ on previous prices, while the purchasing value of gold as regards general commodities is falling $\frac{1}{2}$ °/$_0$ per annum. A proprietor sells half his land this year for £8000 and invests the proceeds at 5 °/$_0$. He proposes to sell the remainder 3 years hence and to invest the money in the same way. What income would now represent the purchasing power of the income he will have obtained when the sales are completed?

Two thalers are worth 7 francs; 11 thalers are worth 10 roubles, 8 roubles are worth 7 dollars, and a dollar is 3*s.* 11$\frac{3}{4}$*d.* I have an equal number of each of the 4 coins. What is the least number of coins I can have in order to get an exact number of pence in exchange?

Express in figures sixty-seven millions thirty-five thousand and twenty-four, and in words 1110011100111. Also find the sum of $\frac{1}{2}+\frac{1}{6}+\cdot\dot{1}\dot{2}+\cdot\dot{1}0\dot{1}$.

Find to 4 places of decimals the square root of 19 and the cube root of 206·425071.

Find the G.C.M. of 8214, 1110, and 1702; also the L.C.M. of 11704, 101080, and 138945.

Find the value of $(3\frac{7}{8}\times 1\frac{1}{17}+4\frac{1}{12}-3\frac{9}{16})\div(5\frac{1}{9}-7\frac{7}{8}\div 28\frac{7}{20}+\frac{1}{3})$, and divide ·0003 by ·0004.

Which pays best, the 3$\frac{1}{2}$ per cents at 88, or the 4·4 per cents at 96$\frac{2}{3}$?

Find the difference between the amounts produced at compound and simple interest respectively by a capital of £1760 at 5 °/$_0$ per annum for 2$\frac{1}{2}$ years, interest being payable half yearly.

Find by Practice the value of 11 tons 6 cwts. 1 qr. 19 lbs. at £4, 1*s.* 10$\frac{1}{2}$*d.* per ton.

If the discount on a bill due 5 months hence at 3$\frac{3}{4}$ °/$_0$ per annum is £774, 12*s.* 6*d.*, what is the amount of the bill?

A room is 38 ft. 3 in. long, and 25 ft. 6 in. wide. How many yards of a carpet 1 yard broad will be required for the floor if a margin of 9 inches in width is left uncarpeted all round the room?

(28.) Two trains on the same railway are running past each other in opposite directions, one 40 and the other 30 miles per hour. Each has an engine and a tender; the first has 12 carriages and the second 17. If the length of an engine and tender be 40 ft. and the length of a carriage 32, and the coupling spaces be each 5 ft., how much time will elapse from the moment that the engines meet till the last carriages of each train have passed each other?

(29.) A man spends a certain capital as follows:—He buys 18,000 acres of uncultivated land, one-third at 27*s.* an acre, one-third at 33*s.*, and one-third at 38*s.* He has the land cleared and ploughed at 8*s.* an acre, and builds farmhouses at a cost of £6400. He then leases 16,000 acres at a yearly rent of 7*s.* an acre, the farm buildings being let at the rate of 2*s.* 3*d.* per pound on their cost price; the remainder of the land he leases to a railway company at 8*s.* an acre. How much per cent per annum does he make on the original outlay?

(30.) Multiply one million one thousand and one by ten thousand one hundred and one, and write out the product in words.

(31.) Reduce $\dfrac{3\frac{3}{7} \text{ of } 2\frac{11}{12}}{\frac{1}{33} \text{ of } 8\frac{9}{14}}$ and $\cdot\dot{0}\dot{4} \div \cdot\dot{7}6923\dot{0}$ to their simplest forms.

(32.) If $\frac{1}{8}$ of a ship be worth £36, 10*s.* 7½*d.*, what part of her may be bought for £125, 5*s.* 0*d.*?

(33.) Explain the principle of the rule called Practice, and find by means of it the value of 17 cwts. 3 qrs. 7 lbs. at £4, 17*s.* 3½*d.* per cwt.

(34.) What decimal of a pound sterling is 7*s.* 7¼*d.*? Prove your result by converting back the decimal into its value.

(35.) Extract the square root of 31 to 4 places of decimals.

(36.) A contractor bought 250 sheep and sold them for £432, 5*s.* 10*d.* at a gain of 16⅔ °/ₒ. What was the cost price of each sheep?

(37.) Find the equated time of payment of £750, of which half is due in 4 months, ⅜ in 5 months, and the rest in 6 months.

(38.) Cube 25: square the result. Put a decimal point between the 3rd and 4th digits from the right hand, and then extract the cube root of the number.

(39.) Find a number of 6 digits with 7 in the units place such that, when the left-hand figure is removed to the right hand, the number thus formed is equal to three times the original number.

(40.) A room is 19 ft. $10\frac{1}{4}$ in. long, 16 ft. $1\frac{3}{4}$ in. broad, and 10 ft. 3 in. high: what will it cost to paint the walls at 1*s.* 7*d.* per square yard?

(41.) A lends B a certain sum; at the same time he insures B's life for £737, 12*s.* 6*d.*, paying annual premiums of £20. At the end of 3 years, and just before the 4th premium is to be paid, B dies, having never repaid anything. What must A have lent B that he may just have enough to recoup himself, together with 5 °/ₒ compound interest on the sum lent and on the premiums?

(42.) Find by means of duodecimals the exact cost of glazing 12 windows, each containing 60 panes, 1 ft. 2′ 3″ long and 11′ 5″ wide, at 3*s.* 8*d.* per square foot.

(43.) If 26 sheep be worth 5 oxen, 2 oxen be equal in value to 3 horses, and 7 horses cost 91 guineas, find value of 1 sheep.

(44.) Simplify $(2 \div 1\frac{1}{2}) \times (3 \div 2\frac{2}{3}) \times (4 \div 3\frac{3}{4})$.

(45.) Simplify $\dfrac{2\frac{1}{5} \text{ of } 3}{3\frac{2}{3} \text{ of } 2} - \dfrac{1\frac{1}{2} \text{ of } 2\frac{2}{3}}{3\frac{3}{4} \text{ of } 4\frac{4}{5}} + \dfrac{\frac{14}{27}}{2\frac{1}{3}} - \dfrac{2\frac{2}{3} - 1\frac{1}{2}}{2\frac{2}{3} + 1\frac{1}{2}}$.

(46.) Simplify $\cdot 1\dot{6} \div \cdot 00\dot{2}\dot{7}$.

(47.) Divide 987654321 by 3509, and ·00321 by ·000011.

(48.) Find the value of $2\cdot 01\dot{3}\dot{6}$ of £2, 1*s.* 3*d.*

(49.) The area of a rectangular field is 87 ac. 1 ro. 26 po. Find its length if the breadth be 462·5 links.

(50.) A block of granite is 17·7 ft. broad, 9·4 ft. thick. What length must be cut off so as to contain 554·6 cubic ft.?

(51.) Extract the square root of 1874161; and to four places of decimals the cube root of ·002.

(52.) What must be the side of a cubical cistern which is to contain 1000 gallons of water if a gallon contain 277·164 cubic inches?

(53.) Divide £144, 10*s.* 0*d.* among 3 persons in the proportion of ·3, ·33, and $\cdot\dot{3}$.

(54.) A merchant invests half of a sum of money in the 3 per cents at 92 and the other half in the $3\frac{1}{2}$ per cents at 98. Which is the better investment?

(55.) A man insures goods for £445, 6*s*. 8*d*., rate of insurance being $4\frac{3}{8}$ $^{\circ}/_{\circ}$. Losing the goods by accident he finds that he recovers both their value and the premium paid. What was their actual value?

(56.) Find the cost at 4 guineas per 100 sq. ft. of paving a yard 21 ft. long by 18 ft. wide, allowing for 4 unpaved spaces each 3 ft. by 2 ft. 6 in. and for a shed 9 ft. square.

(57.) A cistern can be filled by one tap in 3 hrs., by another in 3 hrs. 40 min., and emptied by a third in 2 hrs. and 20 min. If they are all opened together, in what time will the cistern be filled?

(58.) Reduce to a decimal, true to 7 places, $\frac{1}{1\,.\,3}+\frac{1}{1\,.\,3\,.\,5}+\frac{1}{1\,.\,3\,.\,5\,.\,7}+$ &c.

(59.) Add together $3{\cdot}5 + 2{\cdot}8\dot{3} + {\cdot}\dot{6} + 1{\cdot}175$ and simplify (giving in decimals) $\left(\frac{{\cdot}0019}{3{\cdot}1\dot{6}} \text{ of } \frac{4{\cdot}\dot{4}}{{\cdot}0005}\right) \div \left(\frac{8{\cdot}\dot{8}}{7} \text{ of } \frac{4}{5{\cdot}625}\right)$.

(60.) Divide £6, 16*s*. 6*d*. by $\left(\frac{\frac{1}{2} \text{ of } \frac{7}{9}}{\frac{2}{3} \text{ of } \frac{1}{4}} - \frac{\frac{3}{5} \text{ of } \frac{1}{6}}{\frac{5}{8} \text{ of } \frac{1}{7}}\right)$ and express result as decimal of £6, 15*s*. 0*d*.

(61.) If 5 $^{\circ}/_{\circ}$ per annum be the current rate of simple interest, what will be the value of two bills of £246, 13*s*. 4*d*. and £267, 15*s*. 0*d*. on 19th May, if they are due on March 7th and October 12th of the same year respectively?

(62.) A courtyard 15 yds. by 12 yds. is to be paved with pebbles at 3*s*. per sq. yard, except 2 footpaths at right angles to the sides each 4 ft. broad which meet in the centre forming a cross. These are to be laid in paving-stone at 3*s*. 3*d*. per sq. yard. Find the cost of the whole.

(63.) A man possessing money in the 3 per cent consols from which he derives an income of £864, sells out at 90 and invests in shares that pay 5 $^{\circ}/_{\circ}$ interest. If his income be increased by £336, at what price does he buy in?

(64.) If the eightpenny loaf weigh 48 oz. when wheat is at 54*s.* the quarter, what should be the price of wheat when the sixpenny loaf weighs $32\frac{2}{5}$ oz.?

(65.) Six men are set to a piece of work which they could finish alone in 126 days working 6 days in the week. At the end of each week 6 more men are added. In what time will the work be done?

(66.) A fraudulent tradesman removed from a cask a certain quantity of whisky that contained 64 °/o of alcohol, replacing it by diluted spirit containing 8 °/o only of alcohol. The cask was then of 50 °/o strength. What portion of the whole quantity did he take out?

(67.) A railway company spends £1616220 on working expenses during the year; half that sum in laying down new lines, and a third of it in buying rolling stock. The daily receipts are £9238, and at the end of the year a dividend is paid of $6\frac{1}{12}$ on $109\frac{1}{2}$. Find the capital of the company.

(68.) Extract the square root of 30 to five figures, and also the cube root of ·03. What is the side of a square field containing exactly an acre?

(69.) What sum lent at compound interest for 3 years at $7\frac{1}{2}$ °/o will amount to £4969, 3*s.* 9*d.*?

(70.) The product of two numbers is 7710543 and the square of one of them is 335241. Find the other number.

(71.) Find the value of $3\cdot8\dot{1}4285\dot{7}$ of $\frac{5}{89}$ of 20 guineas.

(72.) If a man and 3 boys can do a piece of work in 12 days, and 5 men and 10 boys do the same in 3 days, in what time could a man alone do it?

(73.) Find by duodecimals the volume of air contained in a room 17 ft. 3 in. long, 14 ft. 7 in. wide, and 11 ft. 2 in. high. What will the answer become when expressed in cubic feet and cubic inches?

(74.) Find the edge of a cubical block containing 4053 yds. 12 ft. 1720 in.

(75.) A man leaves an estate of 104 ac. 5 ro. 11 po. to be divided between his 3 sons, each son's share to be proportional to his age. How much did each receive, their ages being 15, 13, and 11 respectively?

(76.) A man devised $\frac{5}{12}$ of his estate to one of his sons, and of the remainder to another, and the surplus to hi widow. The difference of his sons' legacies was £784 What did the widow receive?

(77.) The *Times* issued on the morning of the 1st January 1880 was numbered 29,766. Find the number of th same journal that was published on second Saturday i December, 1877.

(78.) If I invest my money in shares paying £7 per shar when the £100 share is at $122\frac{1}{2}$, I find that I ge £35, 10*s.* a year more than if I invest it in $5\frac{1}{4}$ bonds a 105. What is my capital?

(79.) The cost of whitening the ceiling of a room at the rat of $7\frac{1}{2}$*d.* per square yard is £1, 17*s.* $9\frac{3}{4}$*d.* To paint the walls of the same room cost £29, 6*s.* 8*d.* at 3*s.* 4*d.* per square yard. Find the height of the room, its length being exactly twice its breadth.

(80.) Find the value of $\cdot 3\dot{4}\dot{8} \times \cdot\dot{1}5384\dot{6}$ of $\dfrac{3\frac{5}{16} - 1\frac{1}{4}}{2\frac{5}{11} \text{ of } \frac{1\frac{1}{2}}{9}}$ of £1, 9*s.* 3*d.*

(81.) Find the L.C.M. and G.C.M. of 37800, 51480, and 2425500.

(82.) Reduce to decimal form true to 6 places $\dfrac{1}{2\,.\,5} + \dfrac{1}{2\,.\,5\,.\,8} + \dfrac{1}{2\,.\,5\,.\,8\,.\,11} +$ &c.

(83.) Find the difference between interest and discount of £340 due 6 mos. hence at 4 °/₀ per annum.

(84.) Multiply by duodecimals 11 ft. 4 in. 3 parts by 8 ft. 9 in. 7 parts, and the product by 10 ft. 11 in. What does the result become when expressed in cub. feet, cub. inches, and the fraction of a cub. inch?

(85.) A labourer after paying a quarter of his weekly wages for rent, three-fifths for food, and five-sixths of the remainder for clothes, finds he has $9\frac{3}{4}$*d.* left. What does he earn weekly?

(86.) A hundred ammunition-wagons drawn by 4 horses each reach exactly a mile, and their rate of travelling is $2\frac{1}{4}$ miles per hour. How long will it be after the first leaves the Tower before the last arrives at Colchester, allowing 4 halts of $1\frac{1}{2}$ hours each, and the distance covered being 50 miles?

My income from the 3 per cents, after deducting 5*d.* in the pound income-tax, is £452, 7*s.* 6*d.* I sell out at $78\frac{1}{2}$ and buy 4 per cents at $102\frac{1}{2}$. Find to a penny the alteration in income.

A cube of silver containing 2 cub. ft. 1457 in. is to be coated with gold a thousandth of an inch thick. Find (neglecting fractions of a penny) the value of gold required to cover it, a cub. inch of gold weighing ·697 lb. Troy, and gold being worth £3, 17*s.* 6*d.* an ounce.

A gas meter after being used for 96 days registers 11280 cub. feet as the consumption. The meter is then tested and found to register 17·5 $^{\circ}/_{\circ}$ in excess of the gas actually consumed. Find the amount that ought to be charged at 3*s.* 9*d.* per thousand cubic feet and the average cost per night.

An alloy of silver is mixed with an alloy of gold in the proportion of 11·4 to 2·6. The percentage of dross in the silver alloy is 13·5 and that in the gold 17·35. Find the percentage of dross in the mixture.

) Four candles of different diameters are fixed in sockets at different levels and are lighted together, but when one inch of the longest has burned away the flames are seen to be exactly on a level. One candle is 7 in. long above the socket and would be consumed in 3 hours; the rest in succession are $6\frac{1}{2}$, 6, and $5\frac{1}{2}$ inches long and would burn away respectively in $3\frac{1}{2}$, 4, and $4\frac{1}{2}$ hours. What are the differences of level between the sockets?

) A road passes through 4 towns, A, B, C, and D. From A to B is 9 miles, the road rising uniformly the whole way; from B to C there is a regular decline, the distance being 7 miles; and from C to D there is another rise throughout the entire length of 10 miles. A man leaves A for D at 9 a.m. walking 3 miles an hour up hill and 4 miles an hour down hill. Another man leaves D for A at 9·30 a.m. and walks 4 miles per hour up hill and 5 miles an hour down hill. Find the time and place of their meeting.

) Find the value of $\cdot 41\dot{6}$ of $\frac{\cdot 015 \times 2\cdot 1}{\cdot 035}$ of $\cdot 0\dot{2}8571\dot{4}$ of 11*s.* 8*d.*

) Find the value of $(\frac{1}{20}+\frac{1}{30})+(\frac{1}{20}+\frac{1}{30})^2+(\frac{1}{20}+\frac{1}{30})^3+$ &c. to six places of decimals.

(95.) The difference between the simple and compound interest on a certain sum of money for 3 years at 5 °/₀ is £13, 6*s.* 10½*d.* What is that sum of money?

(96.) Multiply by duodecimals 7 ft. 4 in. 3 parts by 9 ft. 5 in. 7 parts, and the product by 12 ft. 11 inches. What does the result become when expressed in cubic feet, cubic inches, and the fraction of a cubic inch?

(97.) After spending £30 more than $\frac{1}{9}$ of my yearly income I have £70 more than $\frac{2}{3}$ of it left. What is my income?

(98.) A garrison of 3000 men is supplied with provisions for 15 weeks at the rate of 13 oz. per man per day. How many men must leave so that the provisions may last those left for 26 weeks giving each man 10 oz. per day?

(99.) Two rectangular rooms of the same height were papered; the first was 16 ft. long and 14 ft. wide, and the second 14 ft. long and 12 ft. wide. The paper was 1 ft. 9 in. wide and cost 2*s.* 9*d.* per piece of 12 yards, and the hanging cost 9*d.* per piece. The whole expense was four guineas. Find the height of the rooms.

(100.) A garden contains 192 fruit trees. For every 3 apple-trees there were 2 pear-trees, for every 3 cherry-trees there were 2 walnut-trees, there were 2 plum-trees to every 11 apple-trees, and 7 cherry-trees to every 2 plum-trees. Find the number of each sort.

(101.) A nugget weighing 3 lbs. 14 oz. avoirdupois was purchased at £39, 4*s.* per lb. avoirdupois. On separating the quartz from the gold it was found that the gold was to the quartz as 21 to 4. The gold was then sold at £3, 17*s.* 4*d.* per oz. Troy. Find the gain or loss.

(102.) Find the square root of $107\frac{518}{529}$ and the cube root of 347·428927.

(103.) A wagon leaves London for Oxford at 5·30 a.m. at the rate of 6 miles per hour. A coach, whose rate is to that of the wagon as 5 to 3, leaves London some time after, also for Oxford, overtakes the wagon at 10·3 a.m. and proceeds to its destination, where, after remaining an hour, it commences its return journey and meets the wagon 3¾ miles from Oxford. Find the distance between London and Oxford, and the time (1) when the coach leaves London, (2) when it arrives in Oxford,

(3) when it meets the wagon, (4) when it arrives in London, and (5) when the wagon arrives in Oxford.

) Reduce to its lowest terms $\frac{1}{102960}+\frac{121}{566280}+\frac{1}{463320}$.

) Divide 32547631 by successive division by the prime factors of 1155, and show how to obtain the complete remainder.

) Find the square root of ·0036372961 and $24508\frac{1929}{56644}$.

) Find by duodecimals the cubic contents of a room 19 ft. 9 in. long, 14 ft. 8 in. wide, and 11 ft. 3 in. high; also the area of the four walls.

) A, B, C, and D undertake to do a piece of work. A's rate of working is to B's as 3 to 4, B's is to C's as 5 to 4, C's to D's as 5 to 6. A can do the work in 60 hours. Find (1) the time each of the others would take to do it separately, and (2) the time they could all do it working together.

) A piece of metal 5·12 in. long, 3·43 in. wide, and 1·25 in. thick is melted and recast into a perfect cube. Find the length of one side of this cube and the difference made in the amount of surface.

) After paying income-tax of 6*d.* in the pound my income from the 3 per cents at 85 is £780; how much did I invest?

) A train leaves London for Brighton at 8 a.m., and meets another which left Brighton for London 35 minutes later at 9·30 a.m. 30 miles from London. Compare the rates of the two trains. The distance from London to Brighton is 50 miles.

) The population of a country increases 3 °/ₒ annually, but is decreased annually by emigration to the extent of $\frac{1}{2}$ °/ₒ on the whole; what will be the increase per cent in 3 years?

) A tradesman commences business with a certain capital. At the end of the first year he adds $\frac{1}{6}$ to it; at the end of the second year he adds to it $\frac{1}{7}$ of his new capital; at the end of the third year $\frac{1}{8}$ of the capital with which he began that year, and at the end of the fourth year $\frac{1}{6}$ of his last new capital. He then finds that he has in the business £2737. What did he commence with?

(114.) I sell out £40,000 stock in the 3 per cents at 95, and invest the proceeds, half in 4 per cents at 104 and half in 4 per cents at $108\frac{1}{2}$. Find to a penny the difference in my income.

(115.) A man leaves his estate to be divided among his 3 sons and 2 daughters in the following way: The eldest son is to have $\frac{1}{3}$ of the property, the second son a sum equal to $\frac{2}{3}$ of the eldest son's share, and the third a sum equal to $\frac{4}{5}$ of the second. The elder daughter's share is to be equal to $\frac{2}{3}$ of the second and third sons' together, and the second daughter is to have the remainder, which is found to be £520. Find (1) the value of the estate, and (2) the various shares of the other children.

(116.) A cistern 5 ft. long and 3 ft. 6 in. wide filled with water loses by evaporation ·0005 of its depth, and it is found that this loss has amounted to 2 lbs. 5 oz. of water. Find depth of cistern if a c. ft. of water weighs $62\frac{1}{2}$ lbs.

(117.) Extract the square root of $237\frac{402}{841}$ and of 8281·65521296.

(118.) Reduce to a decimal the sum of the four following fractions: $\frac{1}{5 \cdot 6 \cdot 7} + \frac{1}{6 \cdot 7 \cdot 8} + \frac{1}{7 \cdot 8 \cdot 9} + \frac{1}{8 \cdot 9 \cdot 10}$.

(119.) Multiply by duodecimals 11 ft. 3 in. 5 parts by 9 ft. 6 in. 7 parts, and the product by 10 ft. 3 in. What does the product become when expressed in cubic feet, cubic inches, and the fraction of a cubic inch?

(120.) A cubical block contains 43 c. yds. 24 c. ft. 703 c. in. Find the length of its edge and the area of its entire surface.

(121.) Divide £2075 into 2 such sums so that if the first be put out at simple interest for 5 years at $3\frac{1}{4}$ °/₀, and the second for 4 years at 3 °/₀, the interest of the first shall be double that of the second.

(122.) A man whose income is derived from 65 Spanish £100 bonds paying $2\frac{1}{2}$ °/₀, and £5270, 16*s*. 8*d*. 3 °/₀ stock, sells out of the former at 49 and the latter at 96, and invests the whole amount in 3 °/₀ consols at 97. Find how much stock in consols he will hold, and what will be the difference in his income.

(123.) The weight of a shilling being 87 grains, find the weight of a sovereign, the diameter of a sovereign being to that of a shilling as 57 to 60, and the thickness as 21 to 22, and gold being heavier than silver in the proportion of 32 to 19. (The area of a circle varies as the square of its diameter.)

Two boys, A and B, start together from the same point and walk round and round a ring fence in opposite directions till they meet exactly at the starting-point; their last meeting-place before this was 990 yards from it. A's rate is to B's as 5 to 3. Find the distance covered by each.

A rectangular cistern 4 ft. 2 in. long, 2 ft. 8 in. wide, and 2 ft. deep, is $\frac{1}{3}$ full of water. Find the least number of heavy cubical blocks, each measuring 6 in. every way, that can be introduced into the cistern to make the water *just* overflow.

Three guns, A, B, and C, are fired simultaneously at the same target, from which they are distant $\frac{3}{5}$, 1, and 2 miles respectively. The relative velocities of the shots are 6, 5, and 4, and the shot from A strikes the target 3 seconds after firing. In what time after firing will it be struck by the shots from B and C?

A workman has to pave a conservatory 14 ft. $9\frac{1}{2}$ in. square with red and white tiles; the red tiles each measure $2\frac{1}{2}$ in. by $4\frac{1}{4}$ in. and the white are each $2\frac{1}{2}$ in. square. The floor is to be divided into sixteen equal squares paved with white tiles, and separated by 6 cross rows ($2\frac{1}{2}$ in. wide) of red tiles, with a white tile where 2 rows cross. How many tiles of each sort will he use?

Two similar logs of timber, each measuring 18 ft. in length and $8\frac{1}{8}$ in. square sectional area, were sent to be sawn up, each into 11 boards of equal thickness, to floor a room. A saw, which destroys $\frac{1}{8}$ in. of thickness in making its cut, was used, and in consequence there was a deficiency of flooring material. Had similar boards been cut with a saw which destroys only $\frac{5}{11}$ as much, there would have been a surplus of $22\frac{1}{2}$ sq. ft. What was the area of the room?

Find the value of $\left(\frac{2\frac{1}{4} - \frac{2}{3} \text{ of } 1\frac{5}{6}}{\frac{1}{5} \times 3\frac{1}{3} + \frac{13}{36}} - \frac{1}{2\frac{1}{2}}\right) \div \frac{1}{2\frac{1}{3}}$.

Find (by duodecimals) the cost of digging a cellar 18 ft. 4 in. long, 12 ft. 9 in. broad, and 14 ft. 3 in. deep, at 6*d*. per cubic yard.

(131.) A room is 14 ft. 9 in. long, 9 ft. 3 in. broad, and 10 ft. 6 in. high. It contains 2 windows 5 ft. 6 in. by 4 ft., 3 doors 6 ft. by 3 ft., and a fireplace $6\frac{1}{4}$ ft. by 4 ft. How many postage-stamps will it take to cover the walls, a stamp being $\frac{15}{16}$ in. by $\frac{3}{4}$ in., it being supposed that the stamps may be cut if necessary.

(132.) Find the simple interest on £244, 6*s.* 8*d.* from June 15 to Aug. 27, at $6\frac{1}{4}$ $^{\circ}/_{\circ}$.

(133.) Extract the square root of 531922·2489, and find the side of a cube containing 1520 c. ft. 1512 c. in.

(134.) I sell out of the $3\frac{1}{2}$ per cents at $92\frac{3}{4}$, realizing £18,550, of which I reinvest $\frac{2}{5}$ in the 4 per cents at 96, and the remainder in the 3 per cents at 90. What change does my income undergo?

(135.) Show that the discount of any sum is the present worth of the interest on that sum for the same time and at the same rate per cent. What is the sum on which the discount for 3 years at $4\frac{1}{2}$ $^{\circ}/_{\circ}$ is £521, 8*s.* 9*d.*?

(136.) Two houses are built. Twice as many workmen are employed about the second as about the first. The first is 16 months in building and the second is twelve months. The wages of each of the first set of men are $4\frac{1}{2}$*d.* an hour, and they work $10\frac{1}{2}$ hours a day; the wages of each man of the second set are $3\frac{3}{4}$*d.* an hour, and they work 12 hours a day. The cost of the second house is £630. What is the cost of the first?

(137.) A rectangular cistern is 15 ft. 5 in. long, 13 ft. 5 in. broad, and 6 ft. 8 in. deep. Water flows in through a pipe whose aperture is 12 sq. in., with a velocity of 2 ft. 4 in. per second, and flows out through a hole of 7 sq. in. with a velocity of 2 ft. 1 in. per second. How long will it take to fill $\frac{3}{4}$ of the cistern?

(138.) Two men starting from the same point, and walking in opposite directions are $25\frac{1}{2}$ miles apart in three hours; but if they had walked in the same direction they would have been 6 miles apart in 4 hours. Find their rates of walking.

(139.) The present worth of a sum of money due 3 months hence is £850, but if payment were due 6 months hence the P.W. would only be £841, 13*s.* 4*d.* Find the rate $^{\circ}/_{\circ}$.

(140.) Find the square root of $639\frac{220}{289}$ and of $960{\cdot}4 \times 1{\cdot}8 \times {\cdot}08$.

(141.) Express as a vulgar fraction $(1 + 4{\cdot}\dot{0}\dot{9} + 5{\cdot}\dot{6}7\dot{5} + 23{\cdot}\dot{2}1867\dot{3}) \div 9{\cdot}88$.

(142.) Find in cubic yards, feet, and inches the volume of a rectangular solid of which the dimensions are 7 ft. 6 in., 10 ft. 1 in. 6 parts, and 12 ft. 4 in. 6 parts.

(143.) Find the length in feet and the decimal of a foot to 3 places of the edge of a cube, the volume of which is equal to 4397 c. ft.

(144.) A person who had invested a certain sum of money for 3½ years at 4¼ °/o finds that if he had invested it and £100 more for 3 years at 5 °/o the interest would have been £11, 5*s.* more than it is. Find amount invested.

(145.) Three men run a 3-mile race round a course of 528 yds., their rates being as 32, 30, 22. Find the positions of the other two when winner comes in.

(146.) A tank, 56 ft. long and 16 ft. wide, has supports capable of bearing safely 77 tons of water. What is the greatest depth of water that can be safely allowed if a cubic foot of water weigh 1000 oz.?

(147.) A trench 920 ft. long, 17 ft. wide, and 10 ft. deep, is dug by 7 men and 2 boys. It could have been dug in the same time by 6 men and 5 boys. What length of a trench 15 ft. wide and 12 ft. deep could be dug by 5 men and 3 boys in half the time?

(148.) Three persons, A, B, C, jointly own an estate, their shares being as 4, 2½, and 1½. A sells half his share to C, and C sells 100 acres to B, and their shares are then equal. Find the number of acres in their original shares.

(149.) The diagonal of a cube is $21\sqrt{3}$ feet; find the cost of painting its surface at 4*d.* a square yard.

(150.) The first of 5 clerks can copy 3 lines as soon as the second can copy 4, the second can copy 5 as soon as the third can copy 3, the third can copy 7 as soon as the fourth can copy 8, and the fourth can copy 14 as soon as the fifth can copy 17. How many lines will the fifth copy while the first is copying 490?

(151.) If the specific gravity of gold be 19·3 and of copper 8·89, find the specific gravity of a metal containing 11 parts of gold and 1 copper.

(152.) A merchant sells to a retailer at 60 $^{\circ}/_{\circ}$ profit, but the latter failing he only receives 2*s*. 6*d*. in the pound. Find the merchant's gain or loss.

(153.) If each soldier makes per second 2 paces of 28 in. each, how long will a regiment be walking 35 miles?

(154.) Find the true discount on £100 due 1 year hence at 5 $^{\circ}/_{\circ}$. If £500 be invested in the 3 per cents at 97⅝, discount ¼ $^{\circ}/_{\circ}$, find the income arising therefrom.

(155.) Find the cost of papering the walls of a room $13{\cdot}1\dot{6}$ ft. long, $7{\cdot}\dot{0}01\dot{5}$ ft. broad, and $11{\cdot}\dot{4}\dot{1}$ ft. high, at $11{\cdot}1\dot{7}$*s*. per sq. yd.

(156.) If 12 men in 7 days of 9 hrs. each build a wall 19 miles long, how many men could build a similar wall in 28 days of the same length, if 3 of the latter can do as much in ½ hr. as 5 of the former in ¾ hr.?

(157.) If 2 ac. 2 ro. 24 pls. be represented by 5·12, find the value of the unit of measurement in sq. yds. and the decimal of a sq. yd.

(158.) If by selling an article at 5*s*. 6*d*. I gain ⅜ of my outlay, what would I have gained per cent if I sold it for 6*s*. 6*d*.?

(159.) In a pack of cards 50 in number 1 is noted. The pack is divided into 5 equal heaps, and then combined so that the card noted is in the middle heap. If the cards are now dealt into 2 equal heaps, show that the noted card is thirteenth in the heap containing it.

(160.) Silver weighing 3 lbs. 4 dwts. is combined with 10 oz. 6 dwts. of alloy, and in the combination and manufacture $\frac{1}{15}$ of the whole weight is lost. What is the weight of the manufactured plate?

(161.) Express the following product as a recurring decimal: $(2+\frac{1}{2}+\frac{1}{6}+\frac{1}{24}+\frac{1}{120})(\frac{1}{2}-\frac{1}{6}+\frac{1}{24}-\frac{1}{120})$.

(162.) A candidate in an examination, wherein he has to gain half marks at least to pass, has 2 papers of questions placed before him, of which the first carries half as many marks again as the second. On the first paper he gains ·58 of the maximum marks and on the second ·43 of its maximum: does he pass or fail?

(163.) An article of commerce passes successively through the hands of three dealers, each of whom in selling adds as his profit 10 °/₀ of the price at which he bought. If the third dealer sells the article at £33, 5*s.* 6*d.*, what did the first dealer pay for it?

(164.) In a 4-sided figure where 2 sides are parallel to one another, the lengths of these sides are 82 ch. 4 links, and 56 ch. 6 links, and the perpendicular distance between them is 12 ch. 10 links. What is the area of the figure in acres and decimal parts of an acre?

(165.) A circular plate of lead 2 inches in thickness and 8 inches in diameter is converted without loss of weight into spherical shot each of ·05 inch radius. How many shot does it make?

(166.) If the price in shillings of a cwt. of goods be multiplied by 3 and divided by 7, show that the result is the value in farthings of 1 lb. weight.

(167.) Multiply 4327 by 814, also 32856 by 121711 in three lines of multiplication.

(168.) Find the value of $1\frac{5}{6}$ of $\dfrac{\frac{1}{2}+1\frac{1}{12}+\frac{1}{4}}{2\frac{1}{2}-3\frac{1}{3}+4\frac{1}{4}} \times \left(\dfrac{2\frac{1}{2}}{3\frac{1}{7}}+\dfrac{\frac{3}{16}}{1\frac{3}{8}}\right) \div \left(\dfrac{3}{4\frac{1}{2}}+\dfrac{4\frac{1}{2}}{3}\right)$.

(169.) A person shooting at a target hears the bullet strike the target 4 secs. after he fires. A spectator equally distant from the target and the shooter hears the shot strike the target $2\frac{1}{2}$ secs. after he heard the report. Find the velocity of sound, the target being 550 yds. from the marksman.

(170.) I buy 5 shares in a concern at 40; next year the price is 45, and every year after there is a fall of 4. Each year I sell out one share, and find at the end I have neither gained nor lost. What interest did the concern pay?

(171.) A person sells an article at 5 °/₀ profit. If he had bought it at 5 °/₀ less and sold it for 1*s.* less he would have gained 10 °/₀. Find the cost price.

(172.) I have £5000 stock in the 3 per cents which I invest in the $3\frac{1}{2}$ per cents at $87\frac{1}{2}$, thus increasing my income by £5. Find the price of the 3 per cents.

(173.) Two men and 5 boys are employed on a piece of work and they do $\frac{1}{2}$ of it in 6 days. After this 1 man and 1 boy extra are put on and $\frac{1}{3}$ more is done in 3 days.

How many more men must be put on that the work may be finished in one day more?

(174.) In a mile race A starts at 270 paces of 48 inches per minute, B at 300 paces of 44 inches per minute. After 4 minutes B quickens his pace to 320. Which wins, and by how much, and in what time?

(175.) If the weight of 1 cubic foot of water is 62·35 lbs. avoirdupois, find the error in calculating the weight of 1000 cub. feet on the approximate assumption that 1 cub. foot weighs 1000 oz.

(176.) A legacy remains unclaimed for 4 yrs. At the end of that time it amounts to £14586, 1*s.* 6*d.* at 5 $^{\circ}/_{\circ}$ compound interest. Find the original bequest.

(177.) What would £1 be worth at Paris if a bill at Amsterdam of 12 florins 15 cents sells for £1, and 9 florins 50 cents are worth 20 francs at Paris?

(178.) By selling tea at 2*s.* 8*d.* per lb. a merchant gains $\frac{1}{8}$ of his outlay. He then raises the price to 3*s.* 1*d.* per lb. What does he clear $^{\circ}/_{\circ}$ on prime cost?

(179.) The population of a town at the census of 1871 was 55,665. At the census of 1881 it was found to be 63,422. The number of deaths during the 10 years was 17·7 $^{\circ}/_{\circ}$ on the population at first census. What must have been the number of births during the ten years?

(180.) Mercury expands under heat at the rate of $\frac{1}{10000}$ of its volume for every degree (Fahrenheit) of temperature. Find the weight of a column of mercury 6 inches in height, and $\frac{3}{4}$ of a square inch in section at a temperature of 70°; assuming the weight of a cubic foot of water at 60° to be 1000 oz. avoirdupois, and the weight of mercury at the same temperature to be 13·6 that of water.

(181.) At what rate $^{\circ}/_{\circ}$ simple interest will £900 amount to £1120, 10*s.* in 7 years?

(182.) In a factory a certain number of workers receive 50*s.* per week, twice as many who receive 31*s.* 6*d.* a week, and eleven times as many who receive 14*s.* a week. The total amount of a week's wages is £93, 9*s.*; find the number of workmen.

(183.) If 200 men make an embankment 5 miles long in 25 days, how much overtime must 60 men work in order to raise an embankment 2 miles long in 32 days, 12 hours being taken as a day's work?

(184.) Divide £857, 5*s.* 8¼*d.* among 4 persons, A, B, C, and D, so that A may have twice as much as B, B three times as much as C, and C four times as much as D.

(185.) Find the present worth of £2674, 6*s.* due 3 years hence at $4\frac{3}{5}$ °/ₒ.

(186.) The sides of a quadrilateral field ABCD are as follow: AB 200 links, BC 650 links, CD 905 links, and AD 570 links; the diagonal AC is 800 links. Find the area of the field.

(187.) A man engaged to build a house in 12 wks., and agreed to pay £5 for each day or part of a day that the work remained incomplete after that period. To fulfil his contract he engaged 15 men to work 10 hrs. daily; at the end of 3 wks. 10 of the men struck and remained away from their work for a fortnight. After their return the number of working hours was reduced to 9. What was due from the contractor?

(188.) In what time will £2151, 6*s.* 8*d.* amount to £2366, 9*s.* 4*d.* at 2½ °/ₒ simple interest?

(189.) Find the compound interest on £2080 for 3 yrs. at 4 °/ₒ neglecting fractions of a penny.

(190.) A train starts with its full complement of passengers. At the first station it drops ⅓ of these and takes in 96 more. At the next station it drops ½ of the new total and takes in 12 more. On reaching the third station there are found to be 248 left. What number started?

(191.) If a man, his wife, and child consume 36 lbs. bread in 9 days when bread is at 5*d.* the 4-lb. loaf, how much bread a day would a family consisting of a man, wife, and 3 children have to restrict each member to so as not to exceed the same rate of expenditure when the 4-lb. loaf cost 6*d.*? In each case assume the rate of consumption of man, woman, and child to be 4, 3, and 2.

(192.) It appeared from a daily paper that the annual expenses of the Suez Canal might be calculated at about 17,800,000 francs, exclusive of 10,000,000 francs needed for the payment of the interest on the shares. Assuming that all the receipts over and above the sum of these amounts are to be divided as profits among the shareholders, the founders, and the Egyptian government, the holder of shares to take 70 °/ₒ and each of the latter parties 15 °/ₒ, what must the yearly receipts be in order that an English holder of 20 shares, out of the 400,000 representing the whole stock, may receive £73, 10*s.* as his proportion of the profits (£1 = 25 francs)?

(193.) The specific gravities or relative weight of proof spirit and water may be taken as 923 and 1000, disregarding temperature. From a gallon jar filled with proof spirit a certain quantity is drawn off and water added until the vessel is again full. The mixture is then found to have a specific gravity of 992. How much spirit has been abstracted?

(194.) In what proportion must wines at 15*s.*, 20*s.*, 26*s.*, and 30*s.* a gallon be mixed so as to give a profit of 14$\frac{2}{7}$ °/ₒ on the cost if sold at 24*s.* a gallon?

(195.) The sides of a triangular field are 58, 50, and 40 chains. Find its area.

(196.) Find the area of the largest circular plate that can be cut out of a square sheet of iron containing 25,281 inches.

(197.) The base of a rectangular prism is an equilateral triangle with a side of 7 inches, and its height is 24 inches. Find its cubic contents. $\sqrt{3} = 1{\cdot}732$.

(198.) What ready money will discharge a debt of £2113, 16*s.* due 4 months hence at 4$\frac{7}{8}$ °/ₒ per annum simple interest?

(199.) The annual consumption of brandy in a certain country is 4,500,000 gallons, and the duty is 9*s.* 2*d.* per gallon. The duty is reduced 6 °/ₒ and the consumption then rises 8 °/ₒ. How is the revenue affected?

(200.) A schoolmaster having 30 boarders finds that an addition of 5 increases his gross yearly expenditure by £300, but diminishes the average cost per head by £1. What were his original annual expenses?

(201.) Find what weight of water would fall (1) on an acre, (2) on a square mile, in a country where the rainfall is ½ inch.

(202.) A can do a work in 6 days, B in 8 days, and C in 9 days. In what time could they perform the task working all together?

(203.) A man travels 60 miles in 3 hours, partly by rail and partly by coach; if he had gone all the way by rail he would have ended his journey an hour sooner and saved $\frac{2}{5}$ of the time he was on the coach. How far did he go by coach?

(204.) By selling a horse for £42, 10*s*., $7\frac{1}{2}$ °/₀ is lost. Find the gain or loss °/₀ in selling it for £48, 5*s*.

(205.) Find, true to an inch, the diagonal of a square field containing 4 acres.

(206.) Add $\frac{3}{4}$ of $\frac{5}{9}$ of £25, $\frac{2}{7}$ of 5 guineas, $4\cdot\dot{3}\dot{6}$ of £1, 18*s*. 6*d*., and $4\cdot\dot{3}0\dot{9}$ of £2, 15*s*., and reduce the result to the decimal of 30 guineas.

(207.) The cost price of a book is 11*s*. 3*d*. If the expense of sale be 8 °/₀ upon this, and the profit 22 °/₀, what would be the retail price?

(208.) If the three per cents are at 95, and government offers to receive a loan of £5,000,000, the lender to receive five millions in the 3 per cents together with a certain sum in the $3\frac{1}{4}$ per cent stocks. What sum in the $3\frac{1}{4}$ per cents ought the lender to accept?

(209.) Twelve men in 3 groups of 4 each do a work in 12 days. The work done by the several groups in the same time is as 6 to 7 to 8. When half the work is finished, one man of the first group, 2 of the second, and 3 of the third fall out, leaving the work to be completed by the remainder. What extra time will be required?

(210.) Find the value of $\frac{4+(\cdot\dot{1}\div\frac{2}{9})}{2-2(-\cdot\frac{1}{4})}\div\left(\frac{\frac{1}{2}\text{ of }5\cdot5}{2\div\cdot\frac{1}{8}}\cdot7\dot{4}\dot{5}\right)$.

(211.) Two merchants enter into partnership. A brings £1500 more than B, who as acting partner is to have £150 a year for the management. At the end of 3 years the gross profits, computed at 15 °/₀ per annum, are found to be £2925, from which B's salary is to be deducted. It is required to find the stock of each partner and his share of the net profit.

(212.) The sum of two numbers is 342, and one is to the other as 2^5 is to 5^2. Find the numbers.

(213.) What sum invested at 4 °/₀ per annum compound interest would be equal in 15 years to an annuity of £89, 18*s*. 9$\frac{3}{5}$*d*., forborne for the same time at the same rate?

(214.) A's stock is twice that of B, and is kept in trade for $\frac{2}{3}$ of the time that the partnership lasts. B remains in the firm $\frac{4}{5}$ of the time. C, who continues the whole time, contributes half as much as A and B together. How is a profit of £545 to be divided amongst them?

(215.) The successful candidate at an election polled $\frac{3}{5}$ of the voters, and had a majority of 756 over his rival; $\frac{1}{9}$ of the constituency remained unpolled. Required the number that voted for each candidate and the gross number of electors.

(216.) Bought a quantity of wheat for which I gave a bill of £506, 13*s*. 4*d*. payable in 4 months, and immediately after sold one-half for a bill of £262, 12*s*. payable in 3 months, and the other half for a bill of £275, 8*s*. payable in 6 months. Required the gain on each half and the gain °/₀ on the whole, discount being allowed at the rate of 4 °/₀ per annum.

(217.) A rectangular cistern 9 ft. long, 5 ft. 4 in. wide, and 2 ft. 3 in. deep is filled with liquid which weighs 2520 lbs. How deep must a rectangular cistern be which will hold 3850 lbs. of the same liquid, its length being 8 ft. and its width 5 ft. 6 inches?

(218.) What is the principal sum to be placed at simple interest at the rate of 4$\frac{1}{4}$ °/₀ per annum, that in 16 months it may amount to £39, 12*s*. 6*d*.?

(219.) If 20 English navvies, each earning 3*s*. 6*d*. a day, can do the same work in 15 days that it takes 28 foreign workmen, each earning 3 francs a day, to complete in 20 days, taking the value of the franc at 10*d*., determine which class of workmen it is most profitable to employ. If a piece of work done by navvies cost £3000, what would be the cost of the same work done by foreign workmen?

(220.) Reduce $\left(\frac{97}{194}+\frac{291}{388}\right)\div\left(\frac{485}{582}-\frac{291}{388}\right)$. Divide £2·4 by ·00625, and, without using the common rule for the extraction of the square root, prove that $1{\cdot}8\dot{3}$ is the square root of $3{\cdot}36\dot{1}$.

(221.) What is meant by the "course of exchange?" A merchant in New York wishes to remit to London 5110 dollars, a dollar being equal to 4*s.* 6*d.* English, for what sum in English money must he draw his bill when bills on London are at a premium of 9¼ °/o?

(222.) A man purchases £700 stock in the 3 °/o consols at 94½, and also invests £585 in the purchase of Russian 5 °/o stock at 97½. How much stock has he standing in his name? If he sells out of the 3 per cents at 95 and out of the 5 per cents at 96¼, does he gain or lose by the transaction, and how much?

(223.) Simplify $\left(\frac{2\frac{1}{4} \div \frac{4}{9}}{1\frac{1}{80}}\right)^2 \times \sqrt{\frac{\cdot\dot{3} \text{ of } \frac{5}{6}}{\cdot 5 \times \cdot\dot{1}} + \frac{\cdot 3\dot{5}}{\cdot 0\dot{8}}}$.

(224.) A cistern can be filled by one tap in 40 minutes, by a second in 30 minutes, by a third in 35 minutes, and can be emptied by a fourth in 20 minutes; in what time would the cistern be filled if all 4 were opened together?

(225.) Extract the cube root of 333894$\frac{147}{512}$.

(226.) A house is to be built in 30 days: 36 men finish $\frac{4}{9}$ of it in 18 days of 8 hours each. How many additional men must be put to work for 10 hours a day to finish the house in time?

(227.) To find the interest on any sum at 3 °/o one rule is: "Multiply the pounds by twice the number of days, from the product take $\frac{1}{70}$ of itself, cut off 2 figures; the result gives the answer in pence." Prove this.

(228.) Show that $\sqrt{2}$ lies between $\frac{17}{12}$ and $\frac{41}{29}$.

(229.) What time after one o'clock do the hands make an angle of 70°?

(230.) What angle do the hands of a watch make at 27 minutes past 2 o'clock?

(231.) Suppose a halfpenny stamp is $\frac{7}{8}$ in. long and $\frac{2}{3}$ broad, how many would paper a room 20 ft. 4 in. long, 13 ft. 8 in. high, and 12 ft. 6 in. wide?

(232.) Find the price of 87 French ells 5 qrs. 3 nls. of cloth at 13*s.* 8*d.* per yard.

(233.) At what time between 10 and 11 will the hands of a clock be (1) at right angles, (2) in the same straight line, (3) together?

(234.) A wine merchant buys gin at 17*s.* per gallon, and an inferior sort at 15*s.* per gallon. He mixes them in the proportion of 5 of the latter to 7 of the former. At what rate must he sell the mixture to gain 16⅔ °/o?

(235.) What is the difference between the common and true present worth of a bill for £1824, 15*s.* due a quarter of a year hence at 5 °/o?

(236.) A merchant purchases £1400 of stock in the 3 °/o consols at 94½, and invests £2242, 10*s.* in the purchase of 5 °/o stock at 97½. How much stock has he standing in his name if he sells out of each as much as refunds half its own purchase money, the consols selling at 96 and the 5 per cents at 102½?

(237.) Convert 4321 from a scale whose radix is 6 to one whose local value is 5.

(238.) At what rate °/o per annum simple interest will 4½*d.* gain 4*s.* 6*d.* in 28⅘ years?

(239.) A man buys 20 tons of hay, and by selling it at 1*s.* 10½*d.* per bundle gains £3. Had he sold them at 1*s.* 9*d.* the bundle he would have lost £2. Find the weight of a bundle in stones, and the cost price per ton.

(240.) In what year recording an exact number of centuries will the last day next fall on Thursday?

(241.) A retailer buys gin at 3*s.* 9*d.* per gallon, and mixes it with water, allowing 17 parts of gin to 4 parts of water. At what price must he sell the compound to gain 1*s.* 6*d.* per gallon?

(242.) A and B start at the same time from two points 27 miles apart, A going at the rate of 3 miles in 55 minutes and B 2½ miles in 38 minutes. When and where will they meet?

(243.) Assuming that 5 lbs. coffee are worth 7 lbs. chocolate, 10 lbs. chocolate worth 3 lbs. tea, 5 lbs. of tea worth 35 lbs. sugar, 7 lbs. of sugar worth 2 lbs. cocoa, and 1 cwt. cocoa costs £8, 6*s.* 8*d.*, find the price of 1 lb. of coffee. Work by the shortest method you can.

A cubic foot of water weighs 1000 ozs.: find the length of the inner edge of a cubical vessel which holds $1398665\frac{71}{216}$ ozs. of water.

The cash price of goods differs from the credit price, which is 8 °/$_0$ more than the former. Find the cash price of an article the credit price of which is £1, 7*s.*

Two watches point to 2 o'clock on the afternoon of the 1st March: one loses 8 seconds and the other gains 9 seconds in 24 hours; when will one be half an hour before the other, and what time will each watch then show?

Three sacks contain respectively wheat, barley, and oats, in quantities which are to one another as 3 to 4 to 6, and a mixture is taken made up of 60 °/$_0$ from the first sack, 40 °/$_0$ from the second, and 70 °/$_0$ from the third. Find what percentage of the whole quantity of corn is taken away.

By selling needles at $4\frac{1}{2}$*d.* a hundred $\frac{1}{3}$ of the selling price is gained. Find the selling price per 1000 so as to gain 60 °/$_0$ on the prime cost.

If a person invests £$8047\frac{7}{12}$ in the 3 per cents at 89, what income will he have? Brokerage $\frac{1}{8}$ and other expenses $\frac{1}{24}$ °/$_0$.

A person can row 8 miles an hour on still water, and he finds it just takes him twice as long to row up as to row down the river. Find the rate of the stream.

A and B can do a piece of work in 10 days, A and C in 12 days, and B and C in 20 days. How long would each take to do it?

How many bricks, each 9 in. long, $4\frac{1}{2}$ in. broad, and $2\frac{1}{2}$ in. thick, will be required to build a wall $1\frac{1}{2}$ miles long, 8 ft. high, and $2\frac{1}{2}$ ft. thick?

A purse contains £42, 8*s.*, made up of pence, shillings, half-crowns, and sovereigns. The number of half-crowns, pence, sovereigns, and shillings are as the numbers 1, 2, 3, 8. Find how many of each coin are in the purse.

A and B enter into partnership, A contributing £800 and B £1000. At the end of 6 months they admit C, who contributes £600. After the lapse of 3 years they balance the books, discovering a profit of £966. Find the share of each.

(255.) Supposing a man to have received £144 in a year, and that the sum received each month is greater than the receipts of the preceding month by £2. How much must he have received (1) in January, (2) in December?

(256.) Reduce 13027 in the decimal scale to the ternary scale.

(257.) Extract the cube root of 27557·290865125.

(258.) In Fahrenheit's thermometer the freezing and boiling points are marked respectively 32° and 212°, whereas the corresponding points in the Centigrade thermometer are marked 0° and 100°. What degree Centigrade corresponds to 50° Fahr.?

(259.) A single grain of gold can be made to cover 56 square inches. What is the thickness of the layer, a cubic foot of gold weighing 1215 lbs. avoirdupois? Express the answer in inches true to eleven decimal places.

(260.) A lb. of chocolate and a lb. of tea cost 5*s.* 4*d.*; but if chocolate were to rise 50 °/ₒ and tea 5 °/ₒ they would cost 6*s.* 1½*d.* Required the prices of chocolate and tea.

(261.) Simplify $\left\{ \dfrac{\left(\frac{2}{3}\right)^2 \times \sqrt{\frac{1}{9}}}{\frac{3\frac{1}{2}}{1\frac{1}{2}}} \div \frac{4}{9} \text{ of } \frac{16}{21} \right\}^{\frac{1}{2}}$.

(262.) If a boy receive a penny on Saturday the 1st of January, 2*d.* on the following Saturday, 3*d.* the third Saturday, and so on to the last Saturday in the following December. How much will he have received within the time?

(263.) Convert 19 lbs. 2 oz. 13 drs. avoirdupois into troy weight. Express the answer in lbs. ozs., &c.

(264.) If 12 masons, working 8 hours a day for 14 days, build a wall 126 ft. long, 8½ ft. high, and 15 ins. broad, what length of wall 4 ft. 6 in. high and 1 ft. broad would 16 masons build in 12 days of 6 hours each, the latter batch working half again as quick as the former?

(265.) In what time would £325, 10*s.* amount to £368, 15*s.* $9\frac{975489}{1600000}$*d.* compound interest at 4¼ °/ₒ?

(266.) If a man owe a certain amount payable in 2½ years hence, in what time ought he to pay ⅜ of the debt so that he may retain the remainder for 3½ years?

.) Find the present value of a perpetuity of £30 per annum when money is worth $4\frac{1}{2}$ °/ₒ.

.) Thirty-five lbs. of tea are mixed with 25 lbs. of a superior quality, which is worth 1*s.* a lb. more. The mixture is worth 3*s.* 5*d.* per lb. Find the value of each kind.

.) Find the sum of a descending series of an infinite number of terms, the first term being 10 and the common ratio $\frac{1}{3}$.

.) If 20 apples are worth 12 pears, 9 pears worth 4 oranges, 12 oranges worth 240 nuts, find the cost of 25 apples, 5 pears, and 10 oranges, nuts being sold at $4\frac{1}{2}$*d.* per 100.

.) Given the log. of 2 = ·30103 and the log. of 3 = ·4771213, find logs. of $\frac{1}{9}$, $\frac{1}{8}$, ·002, 216, 1·08, $\cdot\dot{2}$.

.) Simplify—

$$(583\tfrac{1}{5} \text{ of } \cdot 078125)^{\frac{1}{2}} \div 30\left(\cdot 048\dot{3} \div \frac{43\frac{1}{2}}{90}\right) \times (3\tfrac{7}{8} + 4 \times \tfrac{21}{32}).$$

.) If a man rows 16 miles in 6 hours against a stream, the rate of which is $3\frac{1}{2}$ miles per hour, in what time would he perform the return journey?

.) A vessel has two apertures A and B by which it can be filled in 10 and 12 minutes respectively; it has also two apertures C and D by which it can be emptied in 6 and 8 minutes respectively. Supposing the vessel to be full, in what time will it be emptied (*a*) by opening A and C, (*b*) by opening all four?

.) Three men own all together 21950 sheep: $\frac{3}{4}$ of the number owned by the first, $\frac{5}{6}$ of that owned by the second, and $\frac{8}{9}$ of that owned by the third are all equal. How many sheep had each?

.) Express $\dfrac{\cdot 2\dot{9}\dot{4}}{\cdot 8\dot{0}\dot{3}}$ of a lb. avoir. in troy oz. dwts. and grs.

.) A gentleman invested the same sum in two different stocks, and his income from one is £212 more than from the other. The stocks being the 3 per cents at $87\frac{1}{2}$ and the $3\frac{1}{2}$ per cents at $93\frac{1}{4}$, which is the better investment, and what sum has been invested in each?

.) A and B together do a piece of work in $6\frac{6}{13}$ days, B and C together in $6\frac{6}{7}$ days, and A and C together in $7\frac{7}{15}$ days. What time will each do it in?

(279.) If A sells goods to B at 5 °/₀ profit, B sells to C at 20 °/₀ profit, and C sells to D at 25 °/₀ profit, what would be A's profit per cent supposing he sold the goods for the price D paid for them?

(280.) At what rate are teas at 2*s.* 8*d.*, 3*s.*, and 3*s.* 9*d.* per lb. to be mixed so as to make the mixture worth 3*s.* 6*d.* per lb.? How many lbs. of the 3*s.* 9*d.* tea would be in a mixture containing 3 qrs. 18 lbs. of the 2*s.* 8*d.* tea? Find also how much of each would make 2 cwts. 18 lbs. of the mixture.

(281.) A tradesman hires a man for 48 days on condition that for every day he works he will receive 2*s.* 3*d.*, but for every day he idles he must pay 1*s.* 2*d.* for board. How many days has he idled supposing he receives £3, 17*s.* 3*d.* at the end of the time?

(282.) A gentleman promising his son £300 a year lets him have the yearly dividend arising from the investment of £1803, 15*s.* in a stock bearing 8 °/₀ at 188. How much will it be necessary to invest in funds paying 5 °/₀ at $117\frac{1}{2}$ to complete the allowance?

(283.) A, B, and C do a work in 15, 16, and 18 days respectively. After working together for $1\frac{1}{2}$ days C withdraws, and in 3 days more undertakes by increasing his rate of working to finish the work in $3\frac{17}{48}$ days. Find the relation which C's second rate of working bears to his first.

(284.) A corporation votes a certain sum for town improvements; $\frac{1}{9}$ of the sum + £100 for sewering, $\frac{2}{15}$ less £300 for flagging, $\frac{3}{8}$ for lighting, and $\frac{1}{18}$ + £50 for waterworks. There then remains $\frac{1}{3}$ of the grant for miscellaneous expenses. Find the amount of the vote.

(285.) After taking 50 galls. of liquor out of a cask $\frac{4}{23}$ of the remainder is found to be 7 galls. Required the cost of the liquor, supposing the price per gallon in shillings to be equal to the square root of the whole number of gallons in the cask?

(286.) The digging of a square fish-pond costs £2460, 7*s.* 6*d.*, and it is found that the cost in pounds per square perch is equal to the number of perches in the side of the square. Find the area of the pond.

What sum must I have invested in the 3½ per cents at 91 if, after investing £4000 in the 3 per cents at 75, and paying an income-tax of 7*d.* in the £ on my total gross receipts, I find my net income to be £524, 5*s.* 0*d.*?

In a pigeon match A fires 5 times to B's 4. A kills 3 birds to every 4 shots fired, and B kills 7 birds to every 8 shots. How many birds will A have killed by the time B has missed 10 shots?

A person sells 2 hhds. of gin, one altogether making 10 °/₀; of the other ⅐ is sold at a profit of 4 °/₀ and the remainder at a profit of 14 °/₀. Find the prime cost per gallon of the gin, supposing the sale of the second vessel to produce £2, 0*s.* 6*d.* more than the first.

Two men rent a field for £40. The first, who pays £15, puts on 2 cows to 5 of the other. How long ought the latter to allow his cattle to graze supposing the time of the former to be 4 mos.?

A man buys a number of sheep for £9259, 13*s.* 0*d.*; the price in shillings of each sheep is equal to the square root of the number purchased. Find the number purchased and the price of each.

A, B, and C can do a piece of work in 5 days. A can do it in 12 days, B in 17 days; how long would it take C to do it?

The cost of 3 turkeys and 5 geese is £1, 15*s.* 0*d.*, and of 19 turkeys and 3 geese is £5, 7*s.* 0*d.* Find the price of a turkey and of a goose.

In a trotting match 1 horse is able to trot 8 miles an hour, and gets a start of 6 miles in a distance of 30 miles. At what rate per hour must a second horse travel so as to arrive at the winning station 5 minutes before the other?

Three merchants entered into partnership on the 1st January, 1860, and agreed to allow their profits to accumulate for 10 years. A subscribed ⅕ of the capital and £1000 besides, B put in ¼ and C ½ of the capital. A withdrew his capital on the 31st December, 1866, B withdrew his on the 30th June, 1868. How is a profit of £35,500 to be divided between them at the end of 10 years? Also find the capital.

At what rate °/₀ per annum will the true discount of £1305 amount to £180 in 3⅕ years?

(297.) Simplify the expression $\dfrac{14{\cdot}7\dot{3}\dot{2} \times 2{\cdot}\dot{9}\dot{6}}{30{\cdot}\dot{9}\dot{0} - 1{\cdot}\dot{4}}$.

(298.) The dimensions of a cistern are 12, 9, and 6 feet. What must be the height of a second cistern equal in content to the first, supposing the bottom of the second to be a square having its side 9 feet?

(299.) In a factory there are 1300 workmen placed under 4 superintendents A, B, C, D. For every 4 men under A there are 5 under C, and for every 9 under B there are 10 under D, and for every 2 under A there are 3 under B. How many are under each?

(300.) Two men travel over the same journey, one travelling progressively, the other uniformly. The former goes a mile on the first day, and travels each day 2 miles farther than on the preceding day. How many miles a day must the second man travel so that each may finish the journey in 21 days?

IV. MATRICULATION EXAMINATION PAPERS,

QUEEN'S COLLEGE, BELFAST.

October, 1877.

(1.) A person derives an income of £100 a year from 3 per cent consols. He sells them and invests in a railway paying dividends on their stock at the rate of $4\frac{1}{2}$ °/ₒ. The consols stand at $93\frac{1}{2}$ and the railway stock at £127. Find how much he improves his income.

(2.) Find the value of 7 sq. yds. 2 sq. ft. at 16*s.* $1\frac{1}{2}$*d.* per sq. yd.; and of 3 drs. 2 scr. 15 grs. at £5, 17*s.* 6*d.* per oz.

(3.) A man walks 11 miles in 3 hours; how long at the same rate will he take to walk 17 miles?

(4.) Add together $\frac{1}{70}$ ton, $1\frac{4}{5}$ qrs. and $52\frac{1}{2}$ lbs., expressing the result as the fraction of a cwt.

(5.) If $\frac{3}{5}$ of a mile cost $\frac{1}{7}$ of a pound sterling, what fraction of a shilling does $\frac{1}{30}$ of a yard cost?

(6.) Calculate the following, each to two decimal places:

$$\frac{\frac{1}{3}-\frac{1}{5}}{\frac{3}{5}-\frac{2}{7}},\quad \frac{{\cdot}003}{{\cdot}00057},\quad \frac{\sqrt{5}-\sqrt{3}}{\sqrt{5}+\sqrt{3}}.$$

October, 1878.

(1.) A man can mow a field in 5 hours. His son can mow it in 7 hours. How long would they take if they worked together?

(2.) Find the price of 271 cwts. 3 qrs. 11 lbs. at £3, 14*s.* 8*d.* a cwt.; and of 2 oz. 5 drs. 1 scr. 10 grs. at £2, 10*s.* an oz.

(3.) Find the interest on £1370 for 117 days at $4\frac{1}{2}$ °/o per annum.

(4.) What fraction of a yard is $\frac{3}{5}$ of $\frac{2}{7}$ of a foot?

(5.) Express as single fractions $\frac{5}{12}+\frac{3}{16}+\frac{1}{8}-\frac{7}{9}$ and $(\frac{3}{2}-\frac{7}{6})\div(\frac{7}{3}-\frac{5}{4})$.

(6.) Divide the product of 3·27 and ·054 by their sum, giving the result to two decimal places.

October, 1879.

(1.) If 27 men can reap a field in 8 hours, how long will 36 men take?

(2.) Find the value of 7 ac. 3 ro. 17 po. at £57, 5*s.* an acre; and of 9 cwts. 3 qrs. 12 lbs. at £5, 2*s.* 8*d.* per cwt.

(3.) Express $\frac{2}{3}$, $\frac{5}{9}$, $\frac{11}{12}$, $\frac{7}{18}$ as fractions having the same denominator, and such denominator as low as possible. Find $\frac{53}{9}$ and $\frac{2}{70}$ each to the third place of decimals.

(4.) If $\frac{3}{5}$ of an estate is worth £5703, 3*s.* 9*d.* how much is $\frac{7}{9}$ of it worth?

(5.) Find the discount on a bill for £1507, 10*s.* due in 57 days at 3 °/o per annum.

(6.) The side of an equilateral △ is 1 foot long. Calculate to three decimal places of a foot the length of the perpendicular let fall from the vertex on the base.

October, 1880.

(1.) Three partners buy a ship. The first contributes £13,500, the second £11,000, the third £8500. She earns £7986 on her first voyage. How do they divide it?

(2.) Find the price of 7 yds. 2 ft. 7 in. at 7*s.* 9*d.* a yard.

(3.) Calculate the discount on £3286 due in 51 days at $3\frac{1}{4}$ °/o.

(4.) A can mow a certain field in 10 hours; B can mow it in 12 hours. How long will they take if they work together?

(5.) What fraction of $\frac{2}{9}$ is $\frac{3}{5}$? How much greater is $\frac{1}{2}+\frac{1}{10}$ than $\frac{1}{3}+\frac{1}{4}$?

(6.) Multiply 57·287 by 46·489 and 3·2 by ·01.

(7.) Calculate to three decimal places $\frac{1}{\sqrt{3}+\sqrt{2}}$.

October, 1881.

(1.) A can walk 4 miles while B walks 5, and B can walk 6 miles while C walks 5. Compare A's rate of walking with C's.

(2.) Find the value of 31 tons, 17 cwts. 3 qrs. at £7, 2*s*. 6*d*. per ton, and of 3 ac. 1 ro. 17 po. at £47 per acre.

(3.) Calculate the interest on £1572, 17*s*. 6*d*. for 100 days at $5\frac{1}{2}$ °/₀ per annum.

(4.) Express $\frac{3}{10}$, $\frac{5}{12}$, $\frac{4}{45}$ as fractions having the same denominator. What fraction of $\frac{3}{7}$ of a £ is $\frac{5}{9}$ of a shilling?

(5.) A man after spending half his income, and giving away $\frac{1}{5}$ of the remainder, has £60 left; what is his income?

(6.) The length of a rectangular room is 23·7 ft., its breadth is 18·4 ft. It contains 5000 cubic feet. Calculate its height in feet to one place of decimals.

(7.) Calculate $\sqrt{13}$ to 3 decimal places.

V. INTERMEDIATE EDUCATION (IRELAND) EXAMINATION PAPERS.

(*No credit will be awarded for an answer unless the work is given in full.*)

Junior Grade, 1879.

(1.) Express in words the product of 54239 by 72.

(2.) Divide two hundred and eighty thousand five hundred and one by three hundred and forty-five.

(3.) Find the number of fourpences in £63.

(4.) Add the following: £4647, 17*s*. $9\frac{1}{2}$*d*.; £5859, 13*s*. $6\frac{3}{4}$*d*.; £7172, 18*s*. $7\frac{1}{2}$*d*.; £9394, 16*s*. $10\frac{1}{4}$*d*.; £8788, 14*s*. $0\frac{3}{4}$*d*.; £567, 11*s*. $3\frac{1}{2}$*d*.; £2486, 0*s*. 11*d*.; £375, 19*s*. $8\frac{3}{4}$*d*.; £5683, 14*s*. $10\frac{1}{2}$*d*.; £3456, 12*s*. $8\frac{1}{4}$*d*.

(5.) Subtract £38, 0*s.* $10\frac{1}{2}$*d.* from £671, 0*s.* $5\frac{1}{4}$*d.*

(6.) Multiply £56, 10*s.* $11\frac{3}{4}$*d.* by 46.

(7.) Divide £282, 14*s.* $5\frac{1}{2}$*d.* by 73.

(8.) How would you prove an exercise in multiplication by means of division?

(9.) Find the difference between ·56 and ·379.

(10.) Compute by Practice the price of 3457 articles at £2, 16*s.* 8*d.* each.

(11.) Find the sum of $\frac{5}{6}$, $\frac{2}{3}$. $\frac{7}{9}$, and $\frac{3}{4}$.

(12.) If I lend a person £100 for 12 weeks, how long ought he in return to let me have a loan of £175?

(13.) Disregarding smaller sums than 1*d.*, find the simple interest of £251, 15*s.* 11*d.* for 2 years at $3\frac{1}{2}$ %.

(14.) What change in value does a fraction undergo when the denominator is doubled, the numerator remaining unaltered?

(15.) If 9 men can reap 8 acres of corn in 12 hours, how many men could reap 28 acres in 18 hours?

(16.) Find the difference between the sum and product of $\frac{5}{8}$, $\frac{7}{10}$, and $\frac{8}{15}$.

(17.) How do you find the first term of a proportion when the remaïning three are given?

Middle Grade, 1879.

(1.) In an exercise in multiplication the product is 12482064 and the multiplier 406; find the multiplicand.

(2.) In an exercise in division the divisor is 7564, the quotient 420, and the remainder 5199; find the dividend.

(3.) How many square feet are there in 5 statute acres?

(4.) Subtract 7 half-crowns from 23 sums of 10*s.* 6*d.* each.

(5.) How would you reduce Irish miles to English miles?

(6.) Add the following: £398, 14*s.* $7\frac{1}{4}$*d.*; £687, 10*s.* 11*d.*; £3214, 0*s.* $10\frac{3}{4}$*d.*; £5076, 13*s.* $8\frac{1}{2}$*d.*; £792, 12*s.* $2\frac{1}{2}$*d.*; £4523, 18*s.* $11\frac{1}{2}$*d.*; £7465, 0*s.* $9\frac{3}{4}$*d.*; £59, 19*s.* $10\frac{1}{2}$*d.*; £8601, 11*s.* $11\frac{3}{4}$*d.*; £640, 17*s.* $10\frac{3}{4}$*d.*; £564, 17*s.* $7\frac{1}{2}$*d.*; £9158, 13*s.* $11\frac{3}{4}$*d.*; £6677, 18*s.* $9\frac{1}{2}$*d.*; £8899, 12*s.* $6\frac{3}{4}$*d.*; £555, 15*s.* 5*d.*

(7.) Explain the distinction between an abstract and a concrete number.

(8.) Add $4\frac{3}{5}$ to $\frac{3}{4}$ of $6\frac{5}{6}$.

(9.) Divide the difference between ·7 and ·12 by ·4.

(10.) *Employing only one aliquot part*, find the rent of 95 ac. 2 ro. 24 po. at £3, 17*s*. 6*d*. per acre.

(11.) How do you find the least common multiple of two numbers?

(12.) Four tourists spend £21, 12*s*. in 9 days; how much at the same rate would 6 tourists spend in 16 days?

(13.) What principal would at 5 °/₀ amount in 7 years to £1320, 6*s*.?

(14.) Extract the square root of 236196.

(15.) A man and his son can do a piece of work in 10 and 15 days respectively; in what time could both together do it?

(16.) Which is the greater, and by how much, $\cdot 1\dot{2}\dot{7}$ of 18*s*. 4*d*. or $\frac{2}{7}$ of 9*s*. 4*d*.?

(17.) Extract the cube root of 493039.

Junior Grade, 1880.

(1.) Reduce forty million three hundred thousand and two grains to pounds troy.

(2.) A gentleman whose income is £750 a year spends 18*s*. 9*d*. a day; what is his annual saving?

(3.) Reduce $\frac{3}{4}$ of $\frac{1}{3}$ of £1 to a fraction of 15 shillings.

(4.) What are prime numbers? When are numbers said to be prime to each other?

(5.) What interest should be paid for the use of £3450 from the 9th June to the 2nd November following, at 4 °/₀ per annum?

(6.) Find the greatest common measure of 104, 286, and 663.

(7.) In 8 days, of 12 hours each, $\frac{4}{9}$ of a wall can be built by 15 masons; how many masons could build $\frac{7}{15}$ of the wall in 9 days of 8 hours each?

(8.) Divide 4·5 by ·00045.

(9.) Compute by Practice the price of 25 cwts. 3 qrs. 14 lbs. at £2, 17*s*. 6*d*. per cwt.

(10.) A bankrupt pays his creditors 9*s*. 5*d*. in the £, and pays £1915, 10*s*. 6*d*. altogether. Calculate the amount of his debts.

(11.) How would you reduce a mixed circulating decimal to a vulgar fraction? Illustrate your answer by an example.

(12.) Travelling 8 hours a day, a man performs a journey of 180 miles in 3 days; how long would he be in performing a journey of 630 miles if he travelled 7 hours a day?

(13.) At what rate per cent per annum would £125 produce £1, 10*s*. simple interest in 219 days?

(14.) How is the value of a ratio obtained? Illustrate your answer by an example.

(15.) What vulgar fraction would if multiplied by $\cdot 58\dot{3}$ give the same result as $\dfrac{3\frac{1}{2} \text{ of } 1\frac{1}{4}}{1\frac{5}{6} \text{ of } 3\frac{3}{4}} \div \dfrac{1\frac{3}{5} \text{ of } 2\frac{1}{4}}{1\frac{1}{10} \text{ of } 2\frac{1}{7}}$?

Middle Grade, 1880.

(1.) Divide one hundred and three million sixty-two thousand and forty-three by $\overline{\text{C}}$DCXLV, and express the remainder in Roman characters.

(2.) Reduce $\frac{1}{2} + \frac{1}{3} + \frac{1}{12}$ of a pound troy to a fraction of a pound avoirdupois—the fraction to be in its lowest terms.

(3.) Find the difference between $\frac{3}{5}$ of £1 and $\cdot\dot{5}7142\dot{8}$ of 21*s*.

(4.) If $3\frac{1}{2}$ shares in a mine cost £11, 5*s*., what will $28\frac{3}{4}$ shares cost when bought after a fall of 7*s*. 6*d*. per share?

(5.) How much would a banker charge for discounting at 4 °/ₒ per annum, on the 9th of June, a 7 months' bill for £416, 3*s*. 4*d*. drawn on the 1st of March?

(6.) Distinguish between *mercantile* and *true* discount; which is the greater, and by how much?

(7.) Determine which is the more advantageous investment, the 3 per cents at $89\frac{1}{2}$ or the $3\frac{1}{2}$ per cents at $98\frac{1}{2}$?

(8.) If 6 men and 9 boys, working 12 hours a day, make a drain 225 yds. long in 9 days, in how many days can 10 men and 12 boys, working $10\frac{1}{2}$ hours per day, make a drain 175 yds. long, the work of a boy being $\frac{2}{3}$ that of a man?

(9.) How much must be invested in the 3 per cents at 90 so as to yield an income of £150 per annum?

(10.) What class of vulgar fractions cannot be converted into terminate decimals?

(11.) Extract to 3 decimal places the cube root of $\dfrac{2\frac{3}{4}}{\frac{5}{8}}$.

(12.) In what time would £740 produce £140, 12*s*. at 5 °/ₒ simple interest?

(13.) By retailing tea at 2½*d.* per oz. a grocer gains 33⅓ %. What did the tea cost him per lb.?

(14.) Find the compound interest on £500 for 2 years at 6 %, the interest falling due half-yearly.

(15.) The greatest common measure ("highest common factor") of 493 and another number is 17, and the least ("lowest") common multiple is 18241; find the other number.

Senior Grade, 1880.

(1.) Required the compound interest upon £410 for 2½ years at 4½ % per annum, the interest being payable half-yearly.

(2.) The carpeting of a room twice as long as it is broad, at five shillings per square yard, cost £6, 2*s.* 6*d.*, and the painting of the walls, at ninepence per square yard, cost £1, 6*s.* 3*d.* What is the height of the room?

(3.) A merchant having bought 23, 24, and 25 qrs. of wheat at 38*s.*, 39*s.*, and 40*s.* per qr. respectively, mixes them. At what price per qr. must he sell the mixture to gain 20 % by the purchase?

(4.) A rectangular tank is 14 ft. long and 10 ft. wide; what must be its depth that it may just contain 31¼ tons of water? (N.B. A cubic foot of water weighs 1000 oz.)

Junior Grade, 1881.

(1.) From three thousand and four millions one hundred thousand seven hundred and ninety-six, subtract seven hundred and one millions and thirty-four.

(2.) Divide £184, 15*s.* 9*d.* by 18¾.

(3.) Divide £792, 7*s.* 6*d.* by £22, 0*s.* 2½*d.*, and state whether the quotient is an abstract or a concrete quantity.

(4.) Reduce 5 cwts. 3 qrs. 25 lbs. to troy ounces.

(5.) Give the rule for finding either extreme of a proportion of four terms when the other three are known; also the rule for finding either mean when the other three terms are known.

(6.) If 5 mules and 2 horses can remove 50 tons of hay in a certain time, find how many tons 7 horses and 3 mules will remove in the same time, 4 mules being equal to 3 horses.

(7.) If $\cdot\dot{6}$ of 7·5 cwts. of butter cost £35, find what 4 lbs. will cost.

(8.) If 30 men can make 1 mile of road in a given time, find how many men would be required to make 16·5 miles in $\frac{1}{8}$ of the same time.

(9.) Find how many days it will take 150 men to excavate a canal 1 Irish mile long, 21 ft. wide, and 9 ft. deep, 75 days having been required by 210 men to excavate a canal 600 yards long, 24 ft. wide, and 6 ft. deep.

(10.) Divide the sum of $\frac{1}{2}+\frac{1}{3}+\frac{5}{6}+2\frac{1}{4}$ of $\frac{4}{9}$ by the difference of $2\frac{1}{12}$ and $1\frac{3}{4}$.

(11.) Reduce to a fraction in its lowest terms

$$\left\{\frac{1}{3}\times 4\frac{1}{8}\times 7\frac{3}{11}-\frac{2\frac{3}{5}}{1\frac{2}{3}}\right\}-\frac{6\frac{7}{15}+7\frac{2}{3}}{8\frac{1}{3}-4\frac{4}{5}}.$$

(12.) Define a decimal fraction, and give rule for reducing vulgar fractions to decimals.

(13.) Express 18*s.* 6*d.* as the decimal of £1.

(14.) Find what decimal multiplied by 3·5 will give the sum of $\frac{1}{4}+\frac{16}{25}+\frac{43}{50}+3\frac{1}{2}$.

(15.) Compute by Practice the cost of 16 tons 6 cwts. 3 qrs. 21 lbs. at £5, 12*s.* 6*d.* per cwt.

(16.) Find by Practice the value of 15 lbs. 3 oz. 5 dwts. of gold at £3, 18*s.* 6*d.* per ounce.

(17.) Determine the interest on £678, 5*s.* 9*d.* at 4 °/₀ per annum for 2 years and 7 months.

(18.) At what rate °/₀ simple interest will £750 amount to £948 in 4 years and 292 days?

Middle Grade, 1881.

(1.) Multiply 37425 by 90137.

(2.) Find the ratio of £24, 8*s.* $3\frac{3}{4}$*d.* to £1, 17*s.* $6\frac{3}{4}$*d.*

(3.) Simplify $7(\frac{1}{2}+\frac{2}{3}-\frac{1}{6})$ of $(\frac{3}{35}+\frac{1}{11})\div 4\frac{1}{4}$.

(4.) Add $1{\cdot}\dot{3}2\dot{3}$ to $1{\cdot}\dot{8}\dot{7}$ and subtract $1{\cdot}\dot{6}$ from the result.

(5.) Divide 1·89 by $\cdot\dot{7}1428\dot{5}$.

(6.) What is the value of 2 acres, 3 roods, 10 perches, 2 yards at 2*s.* 6*d.* the square yard?

(7.) If 15 men working 8 hours a day, and taking Saturday, Sunday, and Monday as holidays, do a piece of work in 5 weeks, how long will it take 10 men working 10 hours a day and full 6 days a week?

(8.) If 84 gallons of methylated spirit cost 24 guineas, how much will 19 gallons cost?

(9.) Find the simple interest on £129 for 3 years and 4 months at 3 °/o.

(10.) A stream 1 inch square in section pours into a cistern at the rate of 15 feet a minute. How many gallons pour hourly into the cistern? (A gallon is nearly 256 cubic inches.)

(11.) Extract the square root of 16297369 and the cube root of 124251499.

(12.) Extract the square roots of $\frac{7}{4}$ and of $\cdot\dot{4}$ to four places of decimals.

(13.) Define interest, rate per cent, present worth. A bill is drawn on *Thursday*, March 17th, 1881, for four months, when is it due reckoning days of grace?

(14.) What sum will buy £1000 consols at 99⅜, brokerage ⅛ °/o?

(15.) A man buys 6 chests of tea weighing 400 lbs. net each for £280. He sells the tea at 2*s.* 11*d.* per lb. How much per cent does he gain?

(16.) What sum will amount to £154, 7*s.* at 5 °/o in three years (compound interest)?

(17.) A bill for £900, drawn January 30th, 1881, for 6 months is discounted March 9th at 5 °/o; what does the banker gain by the difference between true and commercial discount?

(18.) A man sells £1000 new 3 per cents at 95, and buys shares and gains £10 per annum. If the dividend on the shares is at the rate of 8 °/o per annum, what is the price of each £100 share?

Senior Grade, 1881.

(1.) A society collected annually £30, 9*s.* 2¼*d.*, each member contributing as many farthings as there were members; determine the number of members.

(2.) Find the difference between the amounts at simple and compound interest of £895, 16*s.* for 2 years at 3½ °/o.

(3.) A person transfers £11,000 from the 4 °/o at 92 to the 5 °/o at 110. Calculate the difference which results in his income.

What amount of stock in the 3½ °/ₒ will produce the same income as £3560, 18*s.* in the 3 °/ₒ?

Find the quotient of the square root of $\frac{326}{117}$ divided by the square root of $\frac{691}{248}$.

Junior Grade, 1882.

) Add together £876, 17*s.* 9¾*d.*; £95, 8*s.* 10½*d.*; £329, 13*s.* 8¼*d.*; £2540, 5*s.* 7½*d.*; £92, 16*s.* 3¾*d.*; £847, 18*s.* 11½*d.*; £94, 2*s.* 2¼*d.*; £746, 19*s.* 7¾*d.*; £84, 8*s.* 8½*d.*; £256, 17*s.* 10¼*d.*; £3168, 9*s.* 7½*d.*; £866, 0*s.* 8½*d.*

) Find the product of thirty-six thousand seven hundred and four by forty thousand and fifty.

) If a person spend 5*s.* 4½*d.* per day and have saved at the end of the year £21, 18*s.* 1½*d.*, what is his yearly income?

) Find the least common multiple of 13, 14, 48, 70, 117.

) If 7 cwts. 2 qrs. 11 lbs. of flour cost £7, 1*s.* 10*d.*, what will 5 tons 17 cwts. cost?

) If 8 masons build in two days a wall 40 ft. long and 3 ft. high, what height of wall 30 ft. long could they build in 5 days?

) Find the cost of carpeting a room 15 ft. 4 in. by 10 ft. 6 in. with carpet 2 ft. 4 in. wide and costing 3*s.* 6*d.* per yard.

) If 4 men or 10 boys can dig 2 acres of ground in 4 days, in what time will 6 men and 5 boys dig 6 acres 2 roods?

) By how much does $\frac{3}{4}$ of $(\frac{2}{3}+1\frac{1}{2})$ fall short of $7\frac{1}{8}-3\frac{1}{2}$?

) Divide 71·26 by 2·036.

) Which is the greater: $\frac{3}{7}$ of $11\frac{1}{5}$ or $2{\cdot}04 \times 2{\cdot}2\dot{7}$?

) Simplify this fraction: $\frac{(\frac{2}{3}-\frac{1}{4})\,({\cdot}\dot{4}-{\cdot}3)}{\frac{3}{5}\text{ of }2{\cdot}2\div{\cdot}\dot{5}}$.

) Find by Practice the price of 3479⅔ gallons at £2, 18*s.* 4*d.* per gallon.

) What is the interest on £756, 12*s.* for 3 years at 2½ °/ₒ?

) Find by Practice the exact cost of 3 tons 7 cwts. 2 qrs. 16 lbs. at £12, 12*s.* 9*d.* per ton.

Middle Grade, 1882.

(1.) Divide 3389055108 by 37524.

(2.) Multiply 3 ac. 0 ro. 14 po. 10 yds. by 1089.

(3.) Simplify $\dfrac{2\frac{1}{2} + 3\frac{1}{4} \div \frac{4}{5} \text{ of } \frac{13}{20}}{(2\frac{1}{3} + 1\frac{3}{4}) \times 2\frac{4}{7} - 5\frac{1}{4}}$.

(4.) State the rules for addition and division of circulatin decimals.

Find the sum of $\cdot\dot{7}\dot{2} + \cdot\dot{2}1\dot{6}$, and divide the result b $\cdot\dot{1}1793\dot{6}$.

(5.) Find the value of 24 oz. 2 dwts. 8 grs. of gold at £3, 15 the ounce.

(6.) If 1 ton 7 cwts. of steel rails cost £6, 1*s.* 6*d.*, what wil 20 tons cost?

(7.) What sum will amount to £171, 0*s.* 1*d.* in five years at 6 °/ₒ simple interest?

(8.) A cistern has 3 pipes, 2 inflow and 1 outflow. The 2 inflow pipes would separately fill the cistern in 8 and 10 hours respectively, and the outflow pipe would empty it in 5 hours. If all three are open, how long will it take to fill the cistern?

(9.) Extract the square root of 7086244, and the cube root of 14172488.

(10.) The first four figures of a square root are 52·82 and the remainder is ·478. Continue the extraction for three figures more (*a*) by the contracted method, (*b*) by the ordinary method.

(11.) Define compound interest, discount, days of grace. What will £65, 2*s.* 1*d.* amount to in 4 years at 4 °/ₒ compound interest?

(12.) A man buys 100 bales of cotton for £8, 15*s.* a bale, and sells them at 6*d.* per lb. His customer fails and pays 15*s.* in the pound. If the bales average 500 lbs. each, what is his gain?

(13.) A man invests £10500 in railway shares at £94, 7*s.* 6*d.* the £100 share, and receives dividend at £4, 10*s.* per annum per share; what is his annual income (brokerage $\frac{1}{8}$)?

(14.) What is the present worth on May 31st, 1882, of a bill for £1000 drawn March 16th, 1882, for 12 months, interest at 6$\frac{1}{4}$ °/ₒ per annum?

(15.) If the true discount on a bill for 5 months at 6 °/ₒ is £3, 17*s.* 6*d.*, what is the amount of the bill?

Senior Grade, 1882.

(1.) Reduce $\frac{2{\cdot}0\dot{3} - 1{\cdot}\dot{2}\dot{1}}{2{\cdot}0\dot{3} + 1{\cdot}\dot{2}\dot{1}}$ to a vulgar fraction.

(2.) Find the number of square kilometres in a square mile, the yard being ·914383 of a metre, and the kilometre containing 1000 metres.

(3.) The population of a town has increased during the last ten years from 735894 to 852191; what will it be in 20 years hence at the same rate?

(4.) Find the value of the series $\frac{1}{1.2} - \frac{1}{1.2.3} + \frac{1}{1.2.3.4} - \frac{1}{1.2.3.4.5} + \&c.$ to seven places of decimals.

(5.) Reduce $\sqrt{\frac{\sqrt{2}+1}{\sqrt{2}-1}}$ to its simplest form, and give its arithmetical value.

Junior Grade, 1883.

(1.) What effect is produced by placing a cipher (0) to the right or left of (*a*) a whole number, (*b*) a decimal; the decimal point being to the extreme left both before and after the alteration.

(2.) Multiply ninety-seven thousand and one by seventy-six thousand seven hundred and six, divide the product by nine thousand and one, and write your quotient in words.

(3.) Reduce 14 cwts. 3 qrs. 16 lbs. to ounces.

(4.) A man owed a bill of £96, 15*s.* 9¼*d.*, of which he paid on account £52, 16*s.* 10¾*d.*; how much remains due?

(5.) How much will 3 tons 18 cwts. 1 qr. of butter cost at 14*d.* per lb.?

(6.) What is the value of 25 lbs. 8 oz. of silver at 5*s.* per ounce?

(7.) The rent of a farm of 120 acres Irish measure is £87, 10*s.*; how much is that per statute acre?

(8.) If 21 men can dig 20 acres in 8 days, how many acres will 16 men dig in 12 days?

(9.) Add together $2\frac{7}{15}$, $\frac{27}{35}$, $24\frac{5}{7}$, $3\frac{29}{70}$, and $310\frac{1}{21}$.

(10.) What number added to $2\frac{1}{3}$ of $\frac{5}{7} + 2\frac{1}{4}$ of $2\frac{2}{3}$ will make th total $9\frac{2}{3}$?

(11.) Reduce $\cdot 39791\dot{6}$ to a vulgar fraction.

(12.) Find the value of ·125 of £1, 4*s.* added to $\cdot\dot{3}$ of 4*s.* 2*d.*

(13.) Find by Practice the value of 14 acres 3 roods 20 poles at £1, 13*s.* 4*d.* per acre.

(14.) Find how many yards of paper 2 ft. 6 in. wide are required to cover the walls of a room 20 ft. 6 in. long, 9 ft. 6 in. wide, and 13 ft. 6 in. high; and what the cost will be at 7*s.* 4*d.* per dozen yards.

(15.) Calculate at what rate per cent simple interest £325 will amount to £367, 5*s.* in four years.

Middle Grade, 1883.

(1.) There is in a city of five parishes a population of 207318; three parishes have each 48075 and the fourth parish has twice as many as the fifth: find the number in the fifth.

(2.) The soldiers of a regiment received as prize-money £6720; to afford each soldier 15*s.* extra the prize-money should be £7440. How many soldiers were there in the regiment?

(3.) If 8 men and 5 boys complete a work in 8 days of $7\frac{1}{2}$ hrs. each, in how many days of 10 hrs. each could 5 men and 8 boys do three-fourths of the work (1 man being able to do the work of 2 boys)?

(4.) Simplify $(\frac{3}{5} + 1\frac{1}{8} \div \frac{4}{5} \times \frac{5}{9}) \div (4\cdot 2\dot{3}\dot{5} + \cdot 25\dot{3} - 2\cdot 20\dot{8}\dot{6})$.

(5.) Find by Practice the cost of 3 qrs. 8 lbs. 10 ozs. at £1, 8*s.* per cwt.

(6.) Find the simple interest on £386, 14*s.* 9*d.* from 8th October, 1870, to 23d December, 1871, at $3\frac{1}{2}$ per cent.

(7.) Extract the square root of ·004 to 3 places of decimals, and explain the reason of your method of pointing it into periods.

(8.) Without testing by the extraction of the roots, how are we able to say that 37028 is not an exact square and that 5217400 is not an exact cube?

(9.) Extract the cube root of 8701432 to 3 places of decimals.

(10.) If £546, 13*s.* 6*d.* lent at compound interest gain in 2 years £50, 6*s.* $1\frac{3}{4}$*d.*, find the rate per cent per annum.

(11.) A person bought a horse and sold it at a loss of 10 °/o: if he had received £9 more he would have gained 12½ °/o; what did the horse cost him?

(12.) At what price must I invest in the 4 per cents so that after paying sixpence in the pound income-tax I may have 4½ per cent on my money?

(13.) A person buys railway shares at £18 when £15 is paid up, and sells when £24 is paid up, gaining 11⅑ per cent on his invested money. Find the price at which he sold out.

(14.) What is the true present worth of £125 payable at the end of 1 year and also of a sum of £175 payable at the end of 2 years, the rate of interest (simple) being 4 °/o per annum?

(15.) The difference between the ordinary and true discounts on a bill due 9 months hence at 4 per cent per annum is 15*s.*; find the amount of the bill.

Senior Grade, 1883.

(1.) A gallon of water weighs 10 lbs.; a cubic foot of water weighs 1000 ounces; a cubic centimetre of water weighs 1 gramme; a centimetre is ·3937 inch. Find the number of grammes in a pound and the number of cubic centimetres in a gallon, each to 2 places of decimals.

(2.) Find the square root of 216^5 accurate to the nearest unit; and also of $\cdot 00\dot{0}1234567\dot{9}$.

(3.) A person buys articles at 8 shillings a gross. He divides them into 5 equal lots which he sells at 2*s.* a score, 1*s.* 6*d.* a dozen, 1*s.* 3*d.* a dozen, 2*d.* each, 15*s.* a hundred respectively. Find the rate of profit gained.

(4.) A property whose net rental will be £100 for the next five years, and then £150 a year for ever, is to be sold. What is its value, taking market rate of interest at 4 per cent?

Junior Grade, 1884.

(1.) Simplify the following $\dfrac{173\ (97319-2958)}{743}$.

(2.) A man spends £259, 4*s.* 7*d.* a year, and his yearly income is £536, 3*s.* 4*d.* What is he worth at the end of 19 years?

(3.) If 21 men are paid 2*s*. 9*d*. a day each for 313 days, what wages will they have received at the end of that time?

(4.) What is meant by the G.C.M. of two or more numbers? Explain the reason of the rule by which it is found.

(5.) What is the value of 37 lbs. 9 oz. of gold when a mass weighing 23 lbs. 7 oz. costs £1132?

(6.) If 7 men, working 8 hrs. a day, mow 21 acres of grass in 9 days, in how many days will 5 men, working 9 hrs. a day, mow 33 acres?

(7.) What is the cost of 37 tons 19 cwts. and 26 lbs. of wheat at 1*s*. 3*d*. a stone?

(8.) The sum of £66, 7*s*. 5*d*. is distributed between 3 persons, of whom the first gets 3 times as much as the second, and the second 4 times as much as the third; how much does each receive?

(9.) Express in troy weight $\frac{2}{3}$ of $\frac{5}{6}$ $(\frac{1}{2}-\frac{1}{3}+\frac{1}{4})$ of lb. avoir.

(10.) Find the cost of painting the 4 walls of a room at 2*s*. $4\frac{4}{5}$*d*. the sq. yd., the room being $15\frac{8}{9}$ ft. long, $14\frac{2}{3}$ ft. wide, and $12\frac{3}{5}$ ft. high.

(11.) Find the value of $3\cdot\dot{3}42857\dot{1} \times £\cdot4\dot{9}$, first converting these decimals into vulgar fractions.

(12.) Divide ·95375 by ·0109, and reduce the quotient to a vulgar fraction.

(13.) A bankrupt who owes £2978, 6*s*. 8*d*. is able to pay 7*s*. 10*d*. in the £; find by Practice how much he pays in all.

(14.) Find the interest of £219 from January 1st to July 16th at $3\frac{1}{2}$ °/ₒ per annum.

(15.) The interest on a certain sum at 4 °/ₒ per annum for 2 yrs. 9 mos. is £38, 16*s*.; what is the sum?

Middle Grade, 1884.

(1.) Explain the words, abstract number, concrete number, and unit, and find what number £354 becomes when a penny is taken as the unit.

(2.) A bankrupt's liabilities are £5374, 15*s*. 9*d*. (including £106, 5*s*. 9*d*. for rent, taxes, and wages, which have to be paid in full), his assets are £2444, 3*s*. $8\frac{1}{4}$*d*.; what dividend in the £ can he pay his creditors?

(3.) Find to 5 places of decimals the sum of the fractions—

$$2+\frac{1}{1\times2}+\frac{1}{1\times2\times3}+\frac{1}{1\times2\times3\times4}+\frac{1}{1\times2\times3\times4\times5}+$$
$$\frac{1}{1\times2\times3\times4\times5\times6}+\frac{1}{1\times2\times3\times4\times5\times6\times7}+$$
$$\frac{1}{1\times2\times3\times4\times5\times6\times7\times8}+\frac{1}{1\times2\times3\times4\times5\times6\times7\times8\times9}.$$

(4.) Compute by Practice the value of a nugget of gold weighing 16 lbs. 9 oz. 17 dwts. 12 grs. at £4, 4*s*. 6*d*. per oz.

(5.) Assuming that an engine of 40 horse power, working 2 hours, can pump 70 gallons of water from a well 95 yards deep; what quantity of water can a 50 horse power engine pump from a depth of 145 feet, working day and night for 147 days?

(6.) State clearly the rule for reducing a mixed circulating decimal to a vulgar fraction, and apply it to find the value of $529{\cdot}6\dot{2}9\dot{6}$.

(7.) Extract the square root of 0·000003418801.

(8.) Divide the difference of the square roots of 27 and 26 by the sum of the square roots of 27 and 26, and find the result to three places of decimals.

(9.) Extract the cube root of 30664·297.

(10.) A bill for £730 drawn 1st January at 6 mos. is discounted 4th March at 4½ per cent; find the difference between the commercial and true discount.

(11.) A and B enter into partnership for a year. A contributes £500 on the 1st January, and B on the 1st May contributes as much as entitles him to half the gain at the end of the year. What was B's contribution?

(12.) What sum of money will amount to £4802, 15*s*. 3¾*d*. in 2½ years at 5 °/o per annum compound interest?

(13.) How much 3½ °/o stock at 97⅜ can I buy for £4500, and what would be the income therefrom?

(14.) If I sell out £1000 3°/o stock at 93½ and invest the proceeds half in 3½ °/o stock and half in 4 °/o stock, both at 116⅞, what effect will the transfer have upon my income?

(15.) A silk mercer buys 2000 yards silk at 6*s*. 7½*d*. per yard; he sells two-thirds of it at 7*s*. 5*d*. per yard, and the remainder at 6*s*. 10½*d*. per yard. How much °/o does he gain?

Senior Grade, 1884.

(1.) What sum must be invested at 5 % per annum compound interest in order to amount to £3000 at the end of 8 years?

(2.) Find the worth of a bill for £588, 12*s.* 8*d.* drawn 6th March at 6 mos. and discounted 11th June, at 6 % per annum.

(3.) Reduce 123454321 in the senary scale to the decimal and duodenary scales.

Junior Grade, 1885.

(1.) A certain number divided by 321 gives as quotient 1235 and remainder 76; find the number.

(2.) The sum of £102,262,669, 9*s.* 8*d.* is to be divided between 511,324 persons; find what each will receive.

(3.) How many yards of carpet 2 ft. 4 in. in width will be required to cover a room 13 ft. 6 in. long and 12 ft. 3 in. wide?

(4.) Reduce 4 yds. 3 ft. cubic measure to inches.

(5.) If 2731 yards of cloth cost £352, 16*s.* 8*d.*, how many yards can I buy for £396, 18*s.* 9*d.*?

(6.) How many men, working at the rate of 6½*d.* per hour for 27 days of 8½ hours each, can earn the same amount of wages as 26 men working for 17 days of 9 hours each at the rate of 6¾*d.* per hour?

(7.) If a railway journey of 396 miles cost me £4, 19*s.*, how far ought I to be able to travel at a proportional expense for £8, 0*s.* 10½*d.*?

(8.) If, when flour is £17, 8*s.* 9*d.* a ton, 15 shillingsworth suffices 8 men for 6 days, what will be the cost per ton when 10 shillingsworth maintains 9 men for 4 days?

(9.) Simplify $\dfrac{(5\frac{1}{2}+6\frac{1}{2})\div 2\frac{1}{3}}{2\frac{2}{7}\times\frac{3}{14}\times 5\frac{1}{4}}$.

(10.) Reduce $0\cdot06\dot{2}\dot{5}$ of £495 to the fraction of £100.

(11.) Find how many yards of wall-paper 2 ft. 0⅛ in. wide are required to paper the walls of a room 17 ft. 11 in. long, 14 ft. 2½ in. wide, and 16 ft. 1⅓ in. high, and what it will cost at 5½*d.* a yard.

(12.) Reduce £6, 6*s.* 8*d.* to the decimal of 13*s.* 4*d.*

(13.) Find by Practice the cost of 19 ac. 3 ro. and 24 per. at £2, 16*s.* 3*d.* per acre.

(14.) Find what sum of money placed at simple interest will yield £506, 10*s.* in 3 years and 4 months at $4\frac{1}{2}$ °/ₒ per annum.

(15.) The sum of £175 lent at simple interest amounts to £196 in 3 years; calculate the rate per cent per annum.

Middle Grade, 1885.

(1.) Find the difference between twenty-six millions twenty thousand four hundred and six, and seven millions six hundred and twenty-three thousand five hundred and three, and express your answer in words.

(2.) If 20 men in 7 days of 9 hours each dig a trench 30 yards long, 3 yards wide, and 2 yards deep, in how many days of 8 hours each will 24 men dig a trench 15 yards long, 2 yards wide, and 4 yards deep?

(3.) Reduce to its simplest form $\dfrac{\frac{1}{5}\times 2}{1\frac{3}{15}-\frac{2}{3}} - \dfrac{\frac{3}{5}-0\cdot\dot{0}9523\dot{8}}{1\frac{11}{35}-(\frac{1}{7}+\frac{2}{3})}$.

(4.) Reduce $\frac{4}{9}$ of $\frac{7}{11}$ of 5*s.* 6*d.* to the fraction of £1, 12*s.* 8*d.*

(5.) Find what sum now lent will amount to £259, 10*s.* in $4\frac{3}{8}$ years at $3\frac{1}{3}$ °/ₒ per annum simple interest.

(6.) Extract the square root of 3984·1344.

(7.) The sum of the areas of the six faces of a cube is 94 yds. 6 ft. 6 in.; find the edge of the cube in feet and inches.

(8.) Extract the cube root of 303464·448.

(9.) Find in what time £160 will amount to £173, 17*s.* $9\frac{9}{25}$*d.* at $4\frac{1}{4}$ °/ₒ per annum compound interest.

(10.) A person buys a quantity of wine at 16*s.* per gallon; 20 °/ₒ of it is lost through natural causes; find at what price per gallon he must sell it so as to gain 20 °/ₒ on his outlay.

(11.) If I purchase 2276 lbs. of coffee at 1*s.* 9*d.* per lb., and mix it with chicory at $4\frac{1}{2}$*d.* per lb. in the proportion of 3 parts by weight of the former to 2 parts of the latter, at what price per lb. must I sell the mixture to gain 25 °/ₒ, and what will be the gross amount of my profit on the transaction?

(12.) A person invests £2139 in the 5 per cents at 115; he afterwards sells at 135, and invests in the 4 per cents at 93; determine the change in his income.

(13.) A person who invested in $3\frac{1}{2}$ $^\circ/_\circ$ stock when it was at $67\frac{1}{2}$ derives an annual income of £388, 10*s.* from his investment; what was his capital, and how much stock does he own?

(14.) For what amount must goods worth £3517, 10*s.* be insured at $2\frac{1}{2}$ $^\circ/_\circ$ so that in case of loss the value of the goods and the premium may be recovered?

(15.) Determine the true present value of £648, 12*s.* $3\frac{1}{2}$*d.* due 2 years and 9 months hence at $3\frac{1}{2}$ $^\circ/_\circ$ per annum simple interest.

Senior Grade, 1885.

(1.) Three persons, A, B, and C, engage in a speculation, to which A contributes £348, 16*s.* 6*d.*, B £804, 11*s.* 4*d.*, and C £621, 12*s.* 2*d.* The speculation yields £795, 18*s.* 8*d.*: to how much is each entitled?

(2.) A man saves £100 at the end of each year, and allows his savings to accumulate at 4 $^\circ/_\circ$ per annum compound interest; how much is he worth at the end of eight years?

(3.) Find the product of $\frac{5476}{7}$ in the duodecimal scale and $\frac{7}{5476}$ in the octary, and reduce the result to the quinary.

APPENDIX.

In order to render this work more comprehensive it has been deemed advisable to supply, in an Appendix, the Rules of Subtraction and Proportion as generally propounded by writers on Arithmetic. Neither of these rules is recognized in the theory throughout the preceding pages, and neither rule is necessary to the solution of any arithmetical problem strictly so called. The rule and principles of Subtraction are not essential in any examination paper whatever, but a knowledge of the elements of Proportion is sometimes required, as for example in question 17, page 313, and question 5, page 316.

The following brief expositions will, it is hoped, prove quite sufficient, on the one hand for the teacher who may wish to employ both methods of finding the difference between two unequal quantities (viz. by Incremental Addition and also by Subtraction), and on the other for students entering examinations where a question in the subject of Proportion may possibly be offered. Those, however, who wish to continue the study of this most intricate but charming subject of Proportion will obtain the requisite information in any good Algebra, where a more exhaustive treatment of the Progressions, Annuities, and Scales of Notation is also provided.

The questions under Complementary Addition (Simple, p. 52, Exercise 4, and Compound, p. 84, Exercise 37), and Variation (p. 148, Exercise 76), in the text of the work, will afford all the practice needed in the rules of Subtraction and Proportion respectively.

SUBTRACTION.

Subtraction is the method of taking one number or quantity (called the *subtrahend*) from another (and a greater) number or quantity (called the *minuend*), and the result of the subtraction is called the *remainder*. The sign of subtraction ($-$) is called *minus* (meaning less, or less by), and when occurring between two quantities indicates that the second is to be taken (or subtracted) from the first: *e.g.* $17-9=8$ is read seventeen minus nine equals (or is equal to) eight, and means that 9 taken (or subtracted) from 17 leaves 8 as remainder.

In Subtraction, whether simple or compound, the essential principle is that the absolute difference between any two numbers is not affected (or altered) if the same number be added to both the unequal quantities. Thus the difference between 9 and 17 is 8, which difference is not disturbed or changed if we add 13 (or indeed any number whatever) to both quantities, since the difference between 9 and 17 and between (9+13) and (17+13), or 22 and 30, is the same number, 8. It is on this principle that the "Borrowing" or "Carrying" peculiar to Subtraction is based, as laid down in 3° under the subjoined rule.

RULE.—To subtract one simple number from another:

1°. Place the smaller number under the greater, so that units are under units, tens under tens, &c., and draw a straight line under the two lines of figures.

2°. Subtract the units of the subtrahend from the units of the minuend, placing the remainder (vertically) under the units column. Proceed in like manner with each column of integers, and the figures thus set down will be the required remainder.

3°. If (as will continually happen) the figure of the subtrahend indicates a higher number than its fellow digit in the minuend, add 10 to the upper digit; perform the subtraction, and when proceeding to the next left-hand column add 1 to the lower or subtrahend figure before performing the subtraction, which then goes on as before.

This is commonly known as the rule of Simple Subtraction.

Illustrative Examples.

1. Subtract 5132305 from 6957678.

6957678 Minuend.
5132305 Subtrahend.
1825373 Remainder.

Explanation of process.—5 from 8 leaves 3 (down); nothing (or nought) from 7 leaves 7 (down); 3 from 6 is 3 (down); 2 from 7 leaves 5 (down); 3 from 5 and 2 (down) remain; 1 from 9 and 8 (down) are left; take 5 from 6 and 1 (down) is left.

2. Subtract 5783296 from 32140251.

32140251 Minuend.
5783296 Subtrahend.
26356955 Remainder.

Explanation of process.—6 from 1 we cannot, add 10 to the 1, and 6 from $11 = 5$ (down); add 1 to $9 = 10$, then 10 from 5 we cannot, add 10 to $5 = 15$, and 10 from $15 = 5$ (down); add 1 to the subtrahend $2 = 3$, and 3 from 2 we cannot, add 10 to upper $2 = 12$, then 3 from $12 = 9$ (down); and so on with each column until we reach the last 2, when we say $5 + 1 = 6$, and 6 from 2 we cannot, add 10 to the 2 and 6 from $12 = 6$ (down); add 1 to 0 (which is assumed to be placed under the 3 of the minuend), and 1 from $3 = 2$ (down).

Rule.—To subtract one compound quantity from another compound quantity of the same kind.

(It is impossible to subtract so many pounds, shillings, and pence sterling from so many hundredweights, quarters, and pounds avoirdupois; the denominations forming the two compound quantities must be similar in kind.)

1°. Place the lesser quantity under the greater, like denominations being vertically under each other, and draw a straight line.

2°. Beginning at the lowest (or right-hand) denomination, take the lower number, if possible, from the upper and set down the remainder.

3°. If the lower number be greater than the upper add to the upper number as many units of that denomination as make 1 of the next higher denomination, then subtract and put down the remainder.

4°. Now add 1 unit to the lower number of the next column and proceed as before.

This is commonly known as the rule of Compound Subtraction.

Illustrative Examples.

1. Subtract £31, 14*s.* $6\frac{1}{2}$*d.* from £80, 12*s.* $2\frac{1}{4}$*d.*

$$\begin{array}{rrll} \pounds & s. & d. & \\ 80 & 12 & 2\frac{1}{4} & \\ 31 & 14 & 6\frac{1}{2} & \\ \hline \pounds 48 & 17 & 7\frac{3}{4} & \text{Remainder.} \\ \hline \end{array}$$

Explanation of process.—2 farthings from 1 farthing we cannot, add 4 farthings ($= 1$ penny) to the 1 farthing, and 2 from $5 = 3$ (down); add 1 to the 6 in pence column and say 7 from 2 we cannot, add 12 pence ($= 1$ shilling) to the 2 pence, and then 7 from $14 = 7$ (down); 14 and $1 = 15$, 15 from 12 we cannot, add 20 shillings ($= £1$) to the 12, and 15 from $32 = 17$ (down); then $1 + 1 = 2$, 2 from 0 we cannot, add 10, and 2 from $10 = 8$ (down); lastly, $3 + 1 = 4$, and 4 from $8 = 4$ (down).

2. Subtract 3 tons 15 cwts. 2 qrs. 19 lbs. from 7 tons 9 cwts. 2 qrs. 14 lbs.

tons.	cwts.	qrs.	lbs.	
7	9	2	14	
3	15	2	19	
3	13	3	23	Remainder.

Explanation of process.—19 from 14 we cannot, add 28 lbs. (=1 qr.) 28 + 14 = 42, and 19 from 42 = 23 (down); 2 + 1 = 3, 3 from 2 we cannot, add 4 qrs. (= 1 cwt.), 3 from 6 = 3 (down); 15 + 1 = 16, 16 from 9 we cannot, add 20 cwts. (= 1 ton), and 16 from 29 = 13 (down); 3 + 1 = 4, and 4 from 7 = 3.

PROPORTION.

We have already defined Ratio to be the relation of one quantity to another with respect to magnitude, what multiple part or parts one is of the other.

Proportion may be defined as the equality of ratios.

The ratio of 6 to 12 may be stated, 6 : 12 or $\frac{6}{12}$ $(=\frac{1}{2})$.
The ratio of 9 to 18 „ „ 9 : 18 or $\frac{9}{18}$ $(=\frac{1}{2})$.

Now these two ratios are equal, that is, 9 bears the same relation to 18 (half of it) that 6 bears to 12, and this equality of the two ratios is generally expressed in the following way: 6 : 12 :: 9 : 18, which may be read, 6 is to 12 as 9 is to 18, or as 6 is to 12 so is 9 to 18.

It will be observed that where we have two ratios equal to each other (*e.g.* $\frac{6}{12} = \frac{9}{18}$) the cross multiplication gives us identical results, viz. $6 \times 18 = 9 \times 12 = 108$. In the proportion, 6 : 12 :: 9 : 18, 6 and 18 are called the *extremes*, and 12 and 9 are termed the *means*. We therefore find that in any proportion (involving only 2 ratios) the product of the means equals the product of the extremes. From this result the fourth term of a (two ratio) proportion may always be deduced when the other three are given. For let $a : b :: c : d$, then $\frac{a}{b} = \frac{c}{d}$, or $ad = bc$ and $a = \frac{bc}{d}$, $d = \frac{bc}{a}$; $b = \frac{ad}{c}$ and $c = \frac{ad}{b}$.

In the ratio $a : b$, a is termed the Antecedent and b the Consequent.

The method of working questions by Proportion will be *exhibited* in an

Illustrative Example.—If 41 articles cost £13, 14*s.* 2¼*d.*, how much will 34 articles cost at the same rate?

$$41 : 34 :: £13,\ 14s.\ 2\tfrac{1}{4}d. : x$$

$$\therefore\ x = \frac{£13,\ 14s.\ 2\tfrac{1}{4}d. \times 34}{41}$$

$$= \frac{\overset{321}{\cancel{13161}} \times 34}{\cancel{41}}\ q. = 10914\ q.$$

$$= \underline{\underline{£11,\ 7s.\ 4\tfrac{1}{2}d.}}\ \text{Ans.}$$

In what is termed Compound Proportion, where complex problems are involved, each ratio (of like terms) is stated separately in direct relation to the third term, or antecedent of the incomplete (or second) ratio, the required answer being obtained (when all the ratios are stated) by dividing the product of all the means by the product of all the first antecedents.

Illustrative Example.

If 210 men build a wall 168 yards long in 36 days of 10 hours each, how many men will build a similar wall 420 yards long in 180 days of 8 hours each?

$$\begin{array}{rcrcrcl} & & & & \text{Men.} & & \text{Men.} \\ 168 & : & 420 & :: & 210 & : & x \\ 180 & : & 36 & & & & \\ 8 & : & 10 & & & & \end{array}$$

$$x = \frac{\cancel{10} \times \cancel{36} \times \overset{\overset{15}{\cancel{105}}}{\cancel{420}} \times \overset{\overset{35}{\cancel{70}}}{\cancel{210}}}{\cancel{8} \times \cancel{180} \times \underset{\cancel{24}\ \cancel{8}\ 4}{\cancel{168}}}\ \text{men.}$$

$$= \frac{525}{4}\ \text{men.}$$

$$= 131\tfrac{1}{4}\ \text{men or} = \underline{\underline{132\ \text{men.}}}\ \text{Ans.}$$

ANSWERS.

INTEGRAL ARITHMETIC.

NOTATION AND NUMERATION.

Exercise 1. (Page 44.)

1. 501
2. 3017
3. 15500
4. 100060
5. 306007
6. 4020600
7. 10010010
8. 107000016
9. 3000003003
10. 30003030013
11. 106000001600
12. 30000130000013000
13. 1400000000000140000000014
14. 10000000000500000000004001

Exercise 2. (Page 45.)

1. (*a* and *b*) One hundred and twenty-three million, four hundred and fifty-six thousand, seven hundred and eighty-nine.
2. (*a* and *b*) One hundred and twenty million, three hundred thousand, four hundred and five.
3. (*a* and *b*) One hundred and twenty million, thirty thousand, and forty-five.
4. (*a* and *b*) One hundred thousand, and twenty-three.
5. (*a* and *b*) Nine hundred million, two hundred and eighty-seven thousand, and six.
6. (*a* and *b*) Seven hundred million, six hundred thousand, and fifty.
7. (*a*) Twelve billion, thirty thousand, and forty.
   (*b*) Twelve thousand million, thirty thousand and forty.
8. (*a*) Four trillion, five hundred billion, sixty million, seventy thousand, and eight.
   (*b*) Four billion, five hundred thousand and sixty million, seventy thousand and eight.

9. (*a*) Twenty-eight trillion, seventy billion, forty million, ninety thousand, and seventy.

   (*b*) Twenty-eight billion, seventy thousand and forty million, ninety thousand and seventy.

10. (*a*) One quadrillion, two hundred and thirty trillion, forty billion, five hundred million, six hundred and seven thousand.

    (*b*) One thousand two hundred and thirty billion, forty thousand and five hundred million, and six hundred and seven thousand.

---

11. One hundred and two thousand and thirty billion, four thousand million, fifty thousand and six.
12. One trillion, two hundred and three thousand and forty billion, fifty thousand and six hundred million, seven hundred and eight thousand and nine.
13. One hundred and two trillion, three thousand billion, four hundred thousand and five million, and six.
14. One hundred quadrillion, sixty trillion, fifty billion, four hundred million, thirty thousand and twenty.
15. One thousand two hundred and thirty-four trillion, fifty-six billion, seven hundred and eighty thousand million, nine hundred thousand and one.
16. Ten quadrillion, twenty-three thousand and forty trillion, one hundred thousand and one hundred million, seven thousand eight hundred and ninety.
17. One hundred thousand and twenty trillion, thirty billion, four hundred thousand and nine million, eighty thousand and sixty-seven.
18. Nine thousand eight hundred and seventy trillion, six hundred and fifty thousand and thirty-four billion, five hundred and six thousand seven hundred and eighty-nine million, fifty-four thousand two hundred and ten.
19. Two quintillion, one hundred thirty-three thousand one hundred and forty-five quadrillion, sixty-seven thousand and eighty-nine trillion, two hundred and thirteen thousand eight hundred and seventy billion, sixty-two thousand nine hundred and eighty-four million.
20. One hundred quintillion, sixty-four quadrillion, seven trillion, nine thousand billion, eight hundred thousand million, seven hundred thousand and sixty-three.

ROMAN NOTATION.

Exercise 2a. (Page 46.)

1. DV.	
2. MDCCLXXXIII.	11. 1789
3. $\overline{\text{XC}}$XLVIII.	12. 1878
4. $\overline{\text{LXII}}$CXXXII.	13. 5555
5. $\overline{\text{XLI}}$DLXXIX.	14. 2490
6. $\overline{\text{DCCCXXX}}$XXVII.	15. 105562
7. $\overline{\text{LXXX}}$CCCCV.	16. 155509
8. $\overline{\text{MXXI}}$CCCXIV.	17. 10544
9. $\overline{\text{DLXXVIII}}$CXLV.	18. 55599
10. $\overline{\text{MMCXXXV}}$DCCXX.	

SIMPLE ADDITION.

Exercise 3. (Page 48.)

1. 10	9. 1311	17. 40377	25. 28076
2. 13	10. 1970	18. 454683	26. 64434
3. 12	11. 2664	19. 421427	27. 493186
4. 12	12. 2754	20. 3143250	28. 32970
5. 11	13. 26217	21. 2512170	29. 887646
6. 121	14. 22932	22. 284045873	30. 666660
7. 111	15. 33900	23. 106994276	31. 802471
8. 1729	16. 31242	24. 71478	32. 7750362

"*SQUARE*" ADDITIONS. (Page 49.)

Square No. 1.—1. Outside 302. 2. 259 3. 203 4. 141 5. 100.

Square No. 2.—3971.

Square No. 3.—1. Outside 571. 2. 509. 3. 386. 4. 370.
5. 290. 6. 165.

SIMPLE COMPLEMENTARY ADDITION.

Exercise 4. (Page 52.)

1. 8383076
2. 6330159891
3. 7144808554
4. 736507
5. 8929248
6. 1740128
7. 2889835
8. 107009
9. 3229889
10. 1172577
11. 22265
12. 1926308
13. 8899489
14. 898998
15. 2056609
16. 7946988
17. 55539969
18. 4502699
19. 43620
20. 2993699
21. 12997461
22. 53968999
23. 6880884
24. 39221531
25. 3975996
26. 9988969
27. 27089189
28. 5872727
29. 1533339
30. 66889469
31. 8929999
32. 9999899
33. 599969995
34. 467948
35. 243391
36. 63403
37. 4208687
38. 349497
39. 633798
40. 3228961
41. 33609746
42. 16998693
43. 1499999
44. 299985
45. 8699967
46. 8768494
47. 1999888
48. 10011
49. 162808798
50. 769869
51. 9969957
52. 4554756
53. 347988949

SIMPLE MULTIPLICATION.

Exercise 5. (Page 55.)

1.	2.	3.	4.	5.
6430934	33805104	9631344	5528295	32498700
9646401	42256380	14447016	9213825	48748050
16077335	50707656	24078360	12899355	64997400
22508269	59158932	28894032	16584885	81246750
35370137	76061484	38525376	20270415	97496100
41801071	92964036	57788064	23955945	113745450
54662939	135220416	67419408	27641475	129994800
61093873	143671692	77050752	31327005	146244150

6.	7.	8.	9.	10.
44938257	128558304	68418525	38905424	140164614
48395046	137741040	72979760	41337013	147951537
51851835	146923776	77540995	43768602	
55308624	156106512	82102230	46200191	
58765413	165289248	86663465		
62222202	174471984			
65678991				

11.	12.	13.
20917753341368	154372011234417	5556126327488
22148209420272	163452717777618	5903384222956
23378665499176	172533424320819	6597900013892

14.	15.
38526639506173	274737681256935
50380990123457	359272352412915
56308165432099	401539687990905

Exercise 6. (Page 56.)

1.	2.	3.	4.	5.
2147421	1148085	1524640	2004886	215109
6442263	3444255	4573920	8019544	860438
19326789	10332765	13721760	32078176	3441753

6.	7.	8.	9.	10.
1673063	6611225	6129299	6111050	940496
6692252	26444900	24517196	24444200	5642977
26769008	105779600	98068784	97776800	33857863

11.	12.	13.	14.	15.
8966376	7387494	6338514	11506950	316912
53798256	44324964	38031084	69041700	1901475
322789536	265949784	228186504	414250200	11408853

16. 419067188440
17. 33092477328
18. 28795699513879
19. 185738603076738
20. 1636529400
21. 2867864960
22. 103351500
23. 266634058
24. 893395000
25. 237237000
26. 268761483
27. 806126904
28. 91132497
29. 606000134241
30. 299999998316
31. 12014402400000
32. 541804401201456
33. 999999333
34. 501000550050
35. 2053690
36. 226198688334
37. 38519089718
38. 16319880
39. 6790095
40. 6799950
41. 60768396
42. 300510000
43. 7544676
44. 7855468
45. 409846976

Exercise 7. (Page 57.)

1.	2.	3.	4.
202021072	146668968	294665028	227729340
220386624	309634488	308696696	255141205
238752176	418278168	336760032	278335860
257117728	244448280	568282554	303639120
303031608	304202304	589330056	328942380
358128264	358524144	617393392	354245640
449956024	521489664	694567566	417503790

5.	6.	7.	8.
820861002	829629024	6844444299	1979203356
1031338182	375308368	7466066508	2486691396
568288386	414814512	8365431921	1370217708
1199719926	699999489	9125925732	2892681828
1620674286	725925396	9955555344	3907657908
1178672208	760493272	10785184956	3349421064
1389149388	1659258048	11614814568	4110653124

9.	10.
11243250144	8139871278
5086232208	8879859576
9486402309	9948731562
9837843876	10853161704
10306312632	11839812768
20612625264	12826463832
20344928832	13813114896

Exercise 8. (Page 58.)

1.	2.	3.
5317775616	6895847175	475318508418
303668987136	260118861125	2140503658218
1793072465856	122846320100	421570361412
383491603279872	287625711600	128089952833644

4.	5.
148286726126	622997808072
246805202126	623515635192
1333264609776	5647577918856
20283574949736	785295080456976

Exercise 9. (Page 58.)

1.	2.	3.
36175205	48760101	17125660
35546071	49176854	17273295
352000473	465929854	164908295
3497355906	4633043101	1641110660

4.	5.
88242784	74947346
86018176	73041905
827554176	707553758
8242172640	7059023758

Exercise 10. (Page 59.)

1.	2.	3.	4.
31141638	5105079	218773635	66867768
313618314	55588638	217894143	672054840
3144990876	563260383	2196091524	6752969136
31454627190	5666070459		67534419384

5.	6.
8832123	823490096
96172006	82586888384
973496224	8259667610480
9804637877	

Exercise 11. (Page 60.)

1. 9641975409
2. 8641984032
3. 7461805131
4. 624680353
5. 354186415
6. 263096416
7. 1026158573
8. 414613604493
9. 813573798048
10. 740442839796
11. 151424818974
12. 509628424041
13. 706628616507
14. 271681471974

Exercise 12. (Page 60.)

1.	2.	3.	4.
19148277393	9592569252	837407403	6170798781
20060100126	10049358264	877283946	6464646342
20971922859	10506147276	917160489	6758493903
21883745592	10962936288	957037032	7052341464
22795568325	11419725300	996913575	7346189025
23707391058	11876514312	1036790118	7640036586
24619213791	12333303324	1076666661	7933884147
25531036524	12790092336	1116543204	8227731708
26442859257	13246881348	1156419747	8521579269

5.	6.	7.	8.
14046428739	16125248349	6794250477	13623957081
14715306298	16893117318	7117786214	14272716942
15384183857	17660986287	7441321951	14921476803
16053061416	18428855256	7764857688	15570236664
16721938975	19196724225	8088393425	16218996525
17390816534	19964593194	8411929162	16867756386
18059694093	20732462163	8735464899	17516516247
18728571652	21500331132	9059000636	18165276108
19397449211	22268200101	9382536373	18814035969

SIMPLE DIVISION.

Exercise 13. (Page 61.)

1.	2.	3.	4.
43162285—1	22745139	154363—1	13694122—3
28774857	17058854—1	5723490—3	11737819—2
21581142—3	13647083—2	4769575—3	10270591—7

5.	6.	7.	8.
7678018—2	9197770—4	5124865	2924052—6
6718266	8175796	4193071—4	2680381—6
5971792	6689287—7	3843648—9	2474198—4

9.	10.
1968229—6	1255826—10
1816827—3	1166124—12
1687053—12	1088383—3

11.	12.	13.	14.
38798760	58198140	69837768	77597520
29099070	46558512	58198140	66512160
23279256	38798760	49884120	58198140
19399380	33256080	43648605	51731680
16628040	29099070	38798760	42325920

15.	16.	17.	18.
133024320	931170240	3310827520	338607360
116396280	827706880	2708858880	286513920
103463360	677214720	2292111360	266048640
84651840	573027840	2128389120	248312064
71628480	532097280	1986496512	219098880

19.
1146055680
1064194560
993248256
876395520
827706880

20.
133024320
124156032
109549440
103463360
98017920

21.
2793510720
1862340480
1396755360
1117404288
931170240
798145920
698377680
620780160
507911040
465585120
429770880
399072960
372468096
349188840
328648320
310390080
294053760

Exercise 14. (Page 62.)

1. 23977145189—2
7104339315—9
2997143148—42
2. 11713090500—24
8134090625—24
18301703907—12
3615151389—15
3. 1538427201—78
630139781—409
303886854—750
4. 1442703978—90
966498954—96

4. 678803106—270
5. 827579952—114
236451414—2274
6. 41480217—1086
215082610—6
82960435—246
7. 15830888—227
3957722—227
8. 1522103—25801
558075—149023
9. 1919187—305897
10. 1708311—146289

Exercise 15. (Page 64.)

1. 7402—67
2. 250—1
3. 90809
4. 7065
5. 704
6. 3026
7. 2715
8. 594
9. 374—223
10. 2683298199—96
11. *2450935884—71*

12. 10000—8001
13. 1125712—425
14. 506909
15. 391525
16. 7777
17. 130130
18. 12345
19. 609
20. 1858
21. 4321

22. 1234
23. 2406—5
24. 17337—
25. 30079
26. 2378
27. 4763
28. 1882—1
29. 10004—
30. 10000—
31. 907387—

Exercise 16. (Page 65.)

1. 24691357—4
2. 42873197—2
3. 82512759—3
4. 179473042—4
5. 178751224—4
6. 220440660881
7. 1817601412010—4
8. 1836401553086—2
9. 1446297249303—4
10. 167472706864—1

Exercise 17. (Page 65.)

1. 12628859—14
2. 5500517—23
3. 29248635—19
4. 6901679—8
5. 22885557—16
6. 39506172—21
7. 35869804—23
8. 31564938—6
9. 34877306—4
10. 7129578—15

Exercise 18. (Page 65.)

1. 79910213—30
2. 79183029—18
3. 27751778—64
4. 69147306—29
5. 41305974—64
6. 991901234—71
7. 3700577469—20
8. 4211505020—46
9. 5237774677—2

o. 101972581—18

Exercise 19. (Page 66.)

1. 3527336—29
2. 4763688—18
3. 5937270—21
4. 4810075—22
5. 5762650—15
6. 4862327—61
7. 6934655—89
8. 12618431—18
   6680346—3
9. 13173806—41
   9013657—16
10. 10475225—48
    14284398—33

Exercise 20. (Page 67.)

1.	2.	3.
17422826—027	9096161204—224	9879945345—647
0858626—1827	908797384—0404	987105250—5552
077034—80235	90871559—14579	98701641—01943
07615—210816	9087074—130094	9870075—270377
0760—6383962	908706—5951726	987006—6387308

4.

9089795846—249
908161421—1824
90807968—58371
9080715—13 118
908070—6958473

5.

2032483153—962
203065373—6182
20304709—75518
2030452—701261
203045—0873854

57063364
57012002
57006870
5700635-
570063—

7.

3508180320—377
350502264—2321
35047071—87128
3504675—644732
350467—2490524

8.

8912122126—688
890410041—4603
89032990—37552
8903218—907780
890321—0894883

51451829
5140551
5140089
5140042-
514003—

10.

7508348444—828
750159025—5409
7500915 —05535
7500847—597231
750084—0846468

11.

2360218611—072
235809420—1881
23578819—71280
2357860—750321
235785—8628246

1

6264679
6259041
6258477
625842-
62584—

13.

61956539—753
6190077—3291
618952—02166
61894—645108
6189—4589403

14.

556000333—554
55549988—3209
5554498—87719
555444—888665
55544—4388765

1

4493490
4489445
4489041
448900-
44889—

Exercise 21. (Page 68.)

1.

13604054008—7
5830308860—107
4534684669—82
0196547—182

2.

26853814009—31
11508777432—106
8951271336—106
7323767457—31

3.

40333741
17285889
13444580
11000111

4.

8428771899—43
3612330814—18
2809590633—43
2298755972—168

5.

7242931687—18
3104113580—43
2414310562—93
1975345005—168

6

1316872
564373
438957
359147

CONTRACTED MULTIPLICATION.

Exercise 22. (Page 68.)

1. 1067734395
2. 265648930
3. 176089840
4. 62693485
5. 343960765
6. 434856175
7. 4591368225
8. 1094773185
9. 649228680
10. 3187960740
11. 2868420645
12. 3781744605

Exercise 23. (Page 68.)

1. 24691358025
2. 22417808625
3. 17455438575
4. 24070867875
5. 12935957400
6. 20754127025
7. 18802582425
8. 13256197700
9. 15525813525
10. 2635765625

Exercise 24. (Page 69.)

1.	2.	3.	4.	5.	6.
3107182925	2761932075	751026290	4320987615	11269567890	27619320960
3994949475	3551055525	965605230	5555555505	14489444430	35510555520
4882716025	4340178975	1180184170	6790123395	17709320970	43401790080

Exercise 25. (Page 69.)

1. 74074074075
2. 67253425875
3. 52366315725
4. 72212603625
5. 38807872200
6. 62262381075
7. 56407747275
8. 39768593100
9. 46577440575
10. 7907296875

Exercise 26. (Page 70.)

1. 11097081875
2. 9864043125
3. 4024845625
4. 15498445500
5. 111651832125
6. 94551549750

Exercise 27. (Page 70.)

1. 7231404750
2. 34435261500
3. 10572988875
4. 12210055125
5. 8869152750
6. 17861296875

Exercise 28. (Page 71.)

1. 32125835875
2. 55277474000
3. 11921581875
4. 23026044125
5. 71274685125
6. 1080246125
7. 6697530875
8. 2815447250
9. 3996232625
10. 5873301875

Exercise 29. (Page 71.)

1.	2.	3.	4.	5.
91517261	69407294	45425336	74363333	20017877
99837012	75717048	49554912	81123636	21837684
108156763	82026802	53684488	87883939	23657491
207993775	157743850	103239400	169007575	45495175

6.	7.	8.	9.	10.
65729499	54739311	30757353	47365692	113029125
71704908	59715612	33553476	51671664	123304500
89631135	74644515	41941845	64589580	154130625
149385225	124405525	69903075	107649300	256884375

Exercises 30 and 31. (Page 72.)

1.	2.	3.	4.
15145071900	2160493650	17283950600	3478395025
23799398700	3395061450	27160493800	5466049325

5.	6.	7.	8.
3847839450	174803591375	173228432300	157319339975
6046604850	274691357875	272216107900	247216105675

9.	10.
12039404650	13764973075
18919064450	21630671975

PROOFS OF DIVISIBILITY.

Exercise 32. (Page 73.)

I.

1. 2 . 3 . 4 . 6 . 8 . 9 . 12
2. 2 . 3 . 4 . 6 . 8 . 9 . 12
3. 2 . 3 . 4 . 6 . 12
4. 3 . 5 . 9
5. 2 . 3 . 4 . 6 . 8 . 9 . 11 . 12
6. 2
7. 3 . 9 . 11
8. 2 . 4 . 8 . 11
9. 2 . 4 . 8
10. 2 . 3 . 4 . 6 . 8 . 9 . 11 . 12
11. 3 . 5 . 9
12. 2 . 4 . 8 . 11
13. 3 . 5 . 11
14. 2 . 3 . 4 . 6 . 8 . 11 . 12
15. 2 . 3 . 4 . 6 . 8 . 9 . 12
16. 11
17. 5 . 11
18. 2 . 4 . 8 . 11
19. 2 . 3 . 4 . 6 . 9 . 12
20. 2 . 4 . 5 . 10
21. 5 . 11
22. 2 . 3 . 4 . 6 . 8 . 9 . 12
23. 3 . 9 . 11
24. 3 . 5 . 9
25. 3 . 9 . 11
26. 3 . 5 . 11
27. 3 . 5 . 9
28. 5
29. 3 . 5 . 11
30. 3 . 9
31. 11
32. 3 . 9 . 11
33. 3
34. 3 . 9
35. 3 . 9 . 11
36. 3 . 9
37. 3 . 11
38. 3 . 9
39. 11
40. 3 . 9 . 11

II.

1. 5 . 5 . 5 . 5 . 5
2. 2 . 3 . 7 . 7 . 11
3. 3 . 3 . 3 . 5 . 5 . 5
4. 2 . 2 . 2 . 2 . 2 . 2 . 3 . 3 . 7
5. 2 . 3 . 7 . 11 . 11
6. 2 . 2 . 2 . 2 . 2 . 3 . 3 . 3 . 7
7. 2 . 2 . 2 . 2 . 3 . 3 . 7 . 7
8. 3 . 3 . 3 . 3 . 3 . 3 . 11
9. 2 . 2 . 2 . 2 . 3 . 3 . 3 . 3 . 7
10. 2.2.2.2.2.2.2.2.2.2.2.2
11. 2 . 2 . 2 . 3 . 3 . 3 . 3 . 11
12. 3 . 5 . 7 . 7
13. 3 . 3 . 3 . 3 . 3 . 3 . 7
14. 2 . 2 . 3 . 7 . 7 . 7
15. 3 . 11 . 11 . 11
16. 2 . 2 . 2 . 2 . 2 . 2 . 7 . 11
17. 7 . 7 . 11 . 11
18. 2.2.2.2.2.2.2.2.3.3.3
19. 2 . 3 . 11 . 11 . 11
20. 2 . 2 . 3 . 3 . 3 . 3 . 3 . 3 . 3
21. 2 . 2 . 2 . 2 . 2 . 2 . 2 . 7 . 11
22. 2 . 3 . 3 . 7 . 7 . 11
23. 2 . 2 . 3 . 3 . 3 . 3 . 3 . 3 . 3
24. 2 . 2 . 2 . 2 . 3 . 3 . 3 . 3 . 3
25. 2 . 2 . 2 . 7 . 11 . 11
26. 3 . 5 . 5 . 7 . 11
27. 2 . 2 . 2 . 2 . 3 . 3 . 3 . 11
28. 7 . 7 . 7 . 11
29. 2 . 2 . 3 . 3 . 7 . 11
30. 3 . 3 . 3 . 3 . 11 . 11

REDUCTION.

Exercise 33. (Page 76.)

1. 17361 halfpence.
2. 88880 farthings.
3. 193698 halfpence.
4. 786926 farthings.
5. 3720 ”
6. 141962 ”
7. 105210 ”
8. 530927 ”
9. 775657 ”
10. 441039 ”
11. 961601 twopences.
12. 79995 threepences.
13. 84883 fourpences.
14. 37315 sixpences.
15. 12061 half-crowns.
16. 17875 sq. inches.
17. 604800 seconds.
18. 743681 ounces.
19. 7007 grains.
20. 2368813 seconds.
21. 3867319 seconds.
22. 3155760000 seconds. (365¼ days = average year).
23. 10586 ounces.
24. 116¼ inches.
25. 14532 feet.
26. 30260 grains.
27. 88888 cubic inches.
28. 999000 grains.
29. 4930416 sq. inches.
30. 366388 sq. yards.
31. 31556927½ seconds.
32. 31622400 seconds.
33. 3055709 seconds.
34. 25431305 seconds.
35. 85931 grains.
36. 58191 feet.
37. 673328 ounces.
38. 506722 farthings.
39. 1358880 drams.
40. 78256 grains.
41. 9595 farthings.
42. 1574624 drams.
43. 101095 grains.
44. 99204 feet.
45. 643104 sq. inches.
46. 17875 sq. inches.
47. 2181240 seconds.
48. 137036 inches.
49. 91214 grains.
50. 99528 grains.
51. 348595 sq. feet.
52. 200944 grains.
53. 40704 quarts.
54. 2689542 inches.
55. 865170 inches.
56. 582205 ounces.
57. 44387 ounces.
58. 124614 ounces.
59. 2703294 inches.
60. 42281 lbs.
61. 76886 ounces.
62. 81120 feet.
63. 15120 farthings
64. 1186116 inches

Exercise 34. (Page 78.)

1. 314 lbs.
2. 406 ”
3. 497 ”
4. 585 ”
5. 751 ”
6. 890 lbs.
7. 944 ”
8. 1083 ”
9. 1222 ”
10. 1333 ”
11. 23945 lbs.
12. 2872 ”
13. 8275 ”
14. 94258 ”
15. 10789 ”
16. 6
17. 13
18. 1
19. 2
20. 2

Exercise 35. (Page 78.)

1. £8, 8*s.* 2½*d.*
2. £95760
3. £365335, 1*s.* 10¼*d.*
4. £164388, 15*s.* 11½*d.*
5. £956535, 0*s.* 11¼*d.*
6. £852379, 0*s.* 2*d.*
7. £10310384, 19*s.* 10½*d.*
8. £338695, 13*s.* 10¾*d.*
9. £1458666, 15*s.* 0¼*d.*
10. G.1203513, 8*s.* 7*d.*
11. G.19029480, 6*s.* 5¾*d.*
12. G.2106391, 8*s.* 3½*d.*
13. G.29050323, 13*s.* 11*d.*
14. G.3907116, 14*s.* 8¾*d.*
15. G.89285714, 6*s.*
16. £93750000
17. 375000000 crowns.
18. ½G.178571428, 12*s.*
19. M.69444444, 12*s.*
20. M.277777777, 21*s.*
21. ½G.714285714, 6*s.*
22. 1500000000 crowns.
23. G.357142857, 3*s.*
24. £375000000
25. 15625000 lbs. (Troy).
26. 15625000 lbs. (Apoth.)
27. 5739 tons 15 cwts. 3 qrs. $18\frac{6}{7}$ lbs.
28. 11363636 furlongs 14 poles 3 yards.
29. 1420454 miles 4 furlongs 14 poles 3 yards.
30. 473484 leagues 2 miles 4 furl. 14 poles 3 yards.
31. 14348 acres 0 rood 4 poles 3 yards 4 feet.
32. 22 sq. miles 268 acres 0 rood 4 poles 3 yards 4 feet.
33. 2666 poles 2 feet 3 inches.
34. 10 yards 10 cub. feet 10 cub. inches.
35. 147 miles 6 furl. 32 poles 2 yards 2 feet 3 inches.
36. 824 tons 16 cwts. 2 qrs.
37. 1578 miles 2 furl. 10 poles 2 yards 2 feet 4 inches.
38. 44 cwts. 3 qrs. 7 lbs. 3 ounces.
39. 4 tons 15 cwts. 3 qrs. 5 lbs.
40. 2 acres 1 rood 20 poles.
41. 1 lb. 3 oz. 13 dwts. 13 grains.
42. 173 lbs. 7 oz. 6 dwts. 16 grains.
43. 408 lbs.
44. 1 ton 4 cwts. 2 qrs. 4 lbs. 2 ounces.
45. 59 miles 32 poles.
46. 16071428 tons 11 cwts. 1 qr. 20 lbs.
47. 1004464 tons 5 cwts. 2 qrs. 24 lbs.
48. 62779 tons 1 qr. 12 lbs.
49. 416666 days 16 hours.
50. 68493 years 55 days.
51. 771604 cub. yards 25 cub. feet 576 cub. inches.
52. 3515625 loads.
53. £6431855, 9*s.* 1*d.*
54. 1071975 lbs. 10 oz. 18 dwts. 4 grains.

55. 1071975 lbs. 10 oz. 7 drs. 16 grains.
56. 10767 tons 12 cwts. 1 qr. 5 lbs. 15 oz. 4 drs.
57. 25727421 packs 196 lbs.
58. 137212916 ells 1 qr. 3 nails ¼ inch.
59. 32484 leagues 2 furl. 33 po. 1 yd. 1 ft. 112 inches.
60. 1 sq. m. 344 ac. 1 ro. 18 po. 22 yds. 7 ft. 124 inches.
61. 301493 lasts 2 qrs. 1 bus. 3 pks. 1 gal. 2 qts. 1 pint.
62. 21439518 bar. 6 gal. 2 qts.
63. 195 years 290 days 1 hour 27 min. 16 seconds.
64. 765697 tuns 19 gal. 2 quarts 1 pint.
65. G.6125576, 13*s.* 1*d.*

COMPOUND ADDITION.

Exercise 36. (Page 81.)

	£	*s.*	*d.*		£	*s.*	*d.*		£	*s.*	*d.*
1.	1029	15	2¾	7.	2907	12	7¼	12.	100	0	0
2.	9816	5	11	8.	1111	11	11¼	13.	444	4	4
3.	13692	13	8¾	9.	555	0	1	14.	333	3	3½
4.	360	6	10	10.	1335	8	7½	15.	7790	6	1¼
5.	1682	11	6¾	11.	1111	11	11¾	16.	17877	19	3¼
6.	1747	8	10½								

17. 1411 lbs. 11 oz. 1 dwt. 4 grs.
18. 201 lbs. 9 oz. 1 scr. 7 grs.
19. 1385 tons 14 cwts. 17 lbs. 5 oz. 7 drs.
20. 32067 cub. yds. 11 cub. ft. 305 cub. in.
21. 377 lea. 1 mile 6 fur. 12 po. 2 yds. 1 ft. 6 in.
22. 2732 yds. 1 qr. 3 nls. 0¼ in.
23. 2047 sq. mil. 439 ac. 1 ro. 32 po. 17 yds. 7 ft. 115 sq. in.
24. 293 wks. 10 hrs. 35 min.
25. 54 qrs. 1 bush. 3 qts.

COMPOUND COMPLEMENTARY ADDITION.

Exercise 37. (Page 84.)

	£	*s.*	*d.*		£	*s.*	*d.*		£	*s.*	*d.*
1.	86055	16	8½	5.	3188	8	10¾	9.	4	4	4¼
2.	679809	13	10¾	6.	6020	17	8¾	10.	337	17	1¾
3.	7582776	17	4½	7.	0	9	2¾	11.	105	16	9¾
4.	7599	17	9¾	8.	8	8	8¼				

12. 1 ac. 3 ro. 36 po. 26½ yds.
13. 18 cwts. 2 qrs. 26 lbs.
14. 3 fur. 37 po. 4¾ yds.
15. 3 lbs. 4 oz. 17 dwts. 21 grs.
16. 3 yds. 3 qrs. 2 nls. 1¼ in.
17. 2 wks. 5 dys. 23 hrs. 50 secs.
18. 113 lbs. 8 oz. 4 drs. 2 scr. 6 grs.

COMPOUND MULTIPLICATION

Exercise 38. (Page 86.)

	£	s.	d.		£	s.	d.		£	s.	d.
1.	51144	19	8¼	10.	662	7	6	18.	208	2	6¼
2.	35781	17	5¼	11.	348417	0	7½	19.	500	0	6
3.	725382	17	9¼	12.	433877	4	11¾	20.	5759	0	0
4.	11000	5	10	13.	714450	7	4¼	21.	3447	10	2
5.	34753	2	6¼	14.	23375	12	4¾	22.	368977	11	3¼
6.	118	18	6½	15.	23574	11	1½	23.	509281	8	5¾
7.	367	18	4	16.	18266	2	2¼	24.	38071	1	3
8.	3679	3	4	17.	977	14	0¾	25.	310	13	6¼
9.	4347	1	8								

26. 27 tons 6 cwts. 3 qrs. 1 lb. 8 oz.
27. 81 miles 6 fur. 39 poles.
28. 1 ton 1 cwt. 26 lbs. 15 oz.
29. 418 tons 2 qrs. 12 lbs. 15 oz.
30. 66 tons 6 cwts. 3 qrs. 3 oz.
31. 39 yds. 2 in.
32. 10 oz. 10 dwts. 10 grs.

Exercise 39. (Page 87.)

	£	s.	d.		£	s.	d.		£	s.	d.
1.	5	6	5½	11.	36	17	7¼	21.	55	17	9¾
2.	17	2	2¼	12.	38	15	7½	22.	57	0	7½
3.	16	6	11¾	13.	42	4	0¾	23.	63	17	6
4.	21	5	10	14.	36	2	4¾	24.	68	8	9
5.	23	19	0¾	15.	44	2	1	25.	76	0	10
6.	26	12	3½	16.	47	2	11	26.	85	3	4
7.	30	0	8¾	17.	48	13	4	27.	100	7	6
8.	31	3	6½	18.	45	12	6	28.	114	1	3
9.	32	6	4¼	19.	52	1	9¼	29.	130	15	10
10.	*34*	*11*	*11¾*	20.	53	4	7	30.	152	1	8

COMPOUND DIVISION.

Exercise 40. (Page 89.)

	£	s.	d.
1.	24	17	9¾
2.	258	4	11¼
3.	17	0	1¾
4.	0	11	9¾
5.	9723	1	2¼
6.	4804	12	2½—14
7.	2	0	3—3
8.	3	4	7¼
9.	149	17	10
10.	37	13	2½
11.	221	5	0⅓
12.	147	12	4⅓
13.	1100	11	9¼
14.	3	8	11½
15.	113	2	5¼—158

	£	s.	d.
16.	83105	14	11¾
17.	10663	8	11½—32
18.	89	16	6
19.	2187	16	6¾
20.	5	5	6¾
21.	2	15	4½
22.	222	2	2½
23.	2	1	7¾
24.	2	2	2¼
25.	49	19	11¾—2
26.	19	19	11¾
27.	9	0	11¾
28.	432	6	2½
29.	16716	12	7¾
30.	26	13	4¼

31. 1 mile 3 fur. 10 poles 5 yds. 6 in.
32. 16 cwts. 1 qr. 8 lbs. 2 oz.
33. 2 cwts. 3 qrs. 1½ lbs.
34. 4 fur. 8 poles 3 yds. 2 ft.
35. 3 cwts. 3 lbs. 3 drs.
36. 3 cwts. 2 qrs. 12 lbs. 5 oz.
37. 1 bush. 3 pecks 1 gal. 3 quarts 1 pint.
38. 1 fur. 5 poles 2 yds. 2 ft. 8 in.—138.
39. £12, 12*s.* 7*d.*
40. 1 acre 10 poles 4 yds. 2 ft.

Exercise 41. (Page 90.)

1. 9 times.
2. 13 „
3. 7 „
4. 303 persons and 17*d.* over.
5. *a.* 17
b. 37
c. 41
d. 352
e. 1296
f. 208
g. 506
h. 1004
k. 1024
l. 9876
m. 34
n. 35
o. 476
p. 560
q. 970
r. 807
s. 769
t. 29
u. 59
v. 37
w. 67
x. 93
y. 921
z. 10

MISCELLANEOUS QUESTIONS

ON THE PRECEDING RULES.

(I.—Page 92.)

1. 17324026
2. 1200001601
3. Eleven thousand six hundred and three million, seven hundred thousand one hundred and sixty. MMMMMDCCCCLXVII. CCIↃↃDCLXXXIV.
4. 10 miles 5 fur. 5 po. 5 yds. 11 inches.
5. 64873
6. 1859010; 185901
7. £29, 9*s*. 4½*d*.; £16, 10*s*. 9¾*d*.; £7, 6*s*. 3½*d*.; £4, 3*s*. 11*d*.
8. 22 tons 5 cwts. 2 qrs.
9. £2, 14*s*. 1½*d*.
10. 4153227318; 5924718
11. £1, 2*s*. 6*d*.
12. 948007
13. 8408386
14. 57223 in each case.
15. £423, 18*s*. 9*d*.
16. £1, 12*s*. 7½*d*.
17. 417 tons 13 cwts. 1 qr. 19 lbs.
18. 457327
19. £63, 11*s*. 9½*d*.; £36, 8*s*. 2½*d*.
20. 35
21. See Technical Terms (p. 40).
22. 2666 poles 2 ft. 3 in.
23. 5 times £13, 11*s*. 0½*d*.
24. 961 and 16 over (see text).
25. 16 tons 17 cwts. 2 qrs.
26. 2629440 minutes.
27. 72
28. 60748—73; (see text).
29. 1 cwt. 2 qrs. 18 lbs. 14 oz.
30. 17361 halfpence.
31. 10 tons 5 cwts.; 1 ton 2 qrs.
32. 45808416423
33. 6506022250 fr.; 35747375 population.
34. 36218880 bolts.
35. £481, 13*s*. 0¼*d*.; £13, 16*s*. 10½*d*.
36. 9090909
37. £1500, 4*s*.; £125, 0*s*. 4*d*.
38. 7 cwts. 3 qrs. 26 lbs.
39. £8, 13*s*. 4*d*.
40. 224461½ feet.
41. 179685 sq. feet.
42. 49602 feet.
43. 18561 qrs. 7 bush. 1 peck 1 gal. 1 quart 1 pint.
44. £4, 7*s*. 6*d*.
45. A £350; B £450; C £720
46. $4^\circ\ 23'\ 10\frac{8}{13}''$
47. £1, 11*s*. 7½*d*.; £4, 14*s*. 10½*d*.
48. 77 shares.
49. £15, 6*s*. 5¾*d*.
50. £17, 12*s*. 10½*d*.
51. £175, 15*s*. 8¼*d*.; £125, 3*s*. 2¼*d*.
52. 18 lbs. 2 oz. 18 dwts. 3 grs.
53. 2 miles 5 fur. 39 po. 1 yd. 4 in.
54. 27 miles 1 fur. 15 po. 5 yds. 3 in.
55. 37½ lbs.
56. 2 ac. 3 ro. 2 po. 18 yds. 8 ft. 72 in.
57. 701 lbs. 6 oz. 6 dwts. 5 grains.

58. 17 tons 14 cwts. 3 qrs. 21 lbs. 2 oz.
59. 13267583
60. 20942352 sq. feet.
61. 33
62. 1½
63. 313632000 sq. inches.
64. 570240 inches.
65. 93 tuns 2 hhds. 17 gals. qts. 1⅗ pints.

(II.—Page 95.)

1.	2.
16603418952	1233752013
802264963428	1221402143
633377986704	12343695065
2491164344376	123487585117
7204215586284	123498685180156

3.

a. 17246823
17427130695
1742107862802

b. 18495466
18688827690
1868233746284

c. 106941791
108058818815
10802229196834

d. 61735311
62380725615
6235906213314

e. 44985336
45455637240
4543985147664

f. 26232404
26506651860
2649744667096

g. 90159531
91102107915
9107047011594

h. 50341808
50868108720
5085044332192

k. 62417619
63070166835
6304826392506

l. 98137336
99163317240
9912887995664

m. 39836357
40252828005
4023884906518

n. 23733336
23981457240
2397312899664

4.

322299978
337647596
352995214

368342832
399038068
414385686

429733304
445080922

5.

a. 83135—3
16627—3
3325—53
9237—13
7557—43
11876—18
5542—28
2375—53
1847—103
1511—153

b. 43362—4
8672—14
1734—64
4818—4
3942—4
6194—24
2890—64
1238—164
963—139
788—114

. 79443—4
15888—19
3177—94
8827—4
7222—9
11349—4
5296—19
2269—144
1765—94
1444—119

d. 112246
22449—5
4489—105
12471—35
10204—10
16035—5
7483—5
3207—5
2494—80
2040—230

e. 81791—2
16358—7
3271—82
9087—42
7435—32
11684—17
5452—57
2336—157
1817—132
1487—32

f. 47695
9539
1907—100
5299—20
4335—50
6813—20
3179—50
1362—125
1059—200
867—50

g. 163926—2
32785—7
6557—7
18102—42
14902—22
23418—2
10928—32
4683—107
3642—182
2980—132

h. 91530—2
18306—2
3661—27
10170—2
8320—52
13075—27
6102—2
2615—27
2034—2
1664—52

k. 113486—2
22697—7
4539—57
12609—27
10316—52
16212—12
7565—57
3242—82
2521—207
2063—107

l. 178431—2
35686—7
7137—32
19825—32
16221—2
25490—7
11895—32
5098—7
3965—32
3244—57

m. 72429—3
14485—23
2897—23
8047—33
6584—28
10347—3
4828—48
2069 - 73
1609—123
1316—248

n. 43151—2
8630—7
1726—7
4794—27
3922—47
6164—17
2876—57
1232—157
958—207
784—157

6.

a. 2944335
14721675
20610345
26499015
32387685
44165025
73608375

220825125
515258625
90685518
97163055
103640592
103051725
161938425

b. 1611225
8056125
11278575
14501025
17723475
24168375
40280625

120841875
281964375
49625730
53170425
56715120
56392875
88617375

c. 3555910
17779550
24891370
32003190
39115010
53338650
88897750
266693250
622284250
109522028
117345030
125168032
124456850
195575050

d. 2166770
10833850
15167390
19500930
23834470
32501550
54169250
162507750
379184750
66736516
71503410
76270304
75836950
119172350

e. 3944455
19722275
27611185
35500095
43389005
59166825
98611375
295834125
690279625
121489214
130167015
138844816
138055925
216945025

f. 833380
4166900
5833660
7500420
9167180
12500700
20834500
62503500
145841500
25668104
27501540
29334976
29168300
45835900

g. 4905585
24527925
34339095
44150265
53961435
73583775
122639625
367918875
858477375
151092018
161884305
172676592
171695475
269807175

h. 2161105
10805525
15127735
19449945
23772155
32416575
54027625
162082875
378193375
66562034
71316465
76070896
75638675
118860775

k. 2272725
11363625
15909075
20454525
24999975
34090875
56818125
170454375
397726875
69999930
74999925
79999920
79545375
124999875

l. 3883275
19416375
27182925
34949475
42716025
58249125
97081875
291245625
679573125
119604870
128148075
136691280
135914625
213580125

7.

a. 15800433—420
1578621—1608
157847—90834
15784—648771

b. 91654869—441
9157237—1809
915641—30213
91563—306135

c. 86503324—807
8642546—4029
864176—85659
86416—907899

d. 29675405—261
2964869—4725
296460—26316
29645—759501

e. 81514479—222
8144110—8853
814337—79080
81433—46176

HIGHEST COMMON FACTOR.

Exercise 42. (Page 99.)

1. 167
2. 121
3. 111
4. 7
5. 2376
6. 19
7. 23
8. 14
9. 4
10. 18
11. 42
12. 1008
13. 83
14. 55
15. 33
16. 4
17. 11
18. 3
19. 1155
20. 17
21. 629
22. 2223
23. 789
24. 854
25. 25659
26. 10087
27. 1
28. 14245
29. 34567
30. 20121
31. 187
32. 74
33. 35
34. 36
35. 99

LOWEST COMMON MULTIPLE.

Exercise 43. (Page 100.)

1. 31944
2. 32076
3. 8085
4. 28125
5. 27951
6. 105644
7. 103125
8. 83853
9. 99792
10. 235224
11. 31104
12. 74088
13. 34848
14. 34496
15. 297675
16. 498960
17. 88704
18. 274428
19. 19712
20. 51744
21. 30898033320
22. 1995840

Exercise 44. (Page 101.)

1. 13728
2. 3360
3. 6930
4. 1716
5. 459000
6. 71280
7. 609840
8. 396
9. 6300
10. 1591744
11. 720
12. 27720
13. 334639305
14. 456326325
15. 720720
16. 10080
17. 15120
18. 11880
19. 352800
20. 360360
21. 25200
22. 863940
23. 196560
24. 1205820
25. 55440
26. 58968
27. 249480
28. 2882880
29. 7396040282400
30. 139423284

FRACTIONAL ARITHMETIC.

VULGAR FRACTIONS.

Exercise 45. (Page 104.)

1. $\frac{45}{16}, \frac{60}{16}, \frac{75}{16}, \frac{90}{16}$
2. $\frac{28}{17}, \frac{56}{17}, \frac{84}{17}, \frac{112}{17}$
3. $\frac{42}{11}, \frac{56}{11}, \frac{70}{11}, \frac{84}{11}$
4. $\frac{208}{19}, \frac{240}{19}, \frac{256}{19}, \frac{320}{19}$
5. $\frac{96}{9}, \frac{112}{9}, \frac{128}{9}, \frac{144}{9}$
6. $\frac{2275}{100}, \frac{6825}{100}, \frac{11375}{100}, \frac{9009}{100}$
7. $\frac{891}{82}, \frac{9072}{82}, \frac{8181}{82}, \frac{3159}{82}$
8. $\frac{1800}{73}, \frac{8064}{73}, \frac{9000}{73}, \frac{2808}{73}$
9. $\frac{704}{65}, \frac{4800}{65}, \frac{6464}{65}, \frac{6336}{65}$
10. $\frac{6328}{57}, \frac{5432}{57}, \frac{5992}{57}, \frac{25720}{57}$

Exercise 46. (Page 104.)

1. $\frac{3}{16}, \frac{3}{24}, \frac{3}{32}$
2. $\frac{7}{27}, \frac{7}{36}, \frac{7}{45}$
3. $\frac{2}{44}, \frac{2}{55}, \frac{2}{66}$
4. $\frac{4}{65}, \frac{4}{78}, \frac{4}{91}$
5. $\frac{7}{90}, \frac{7}{105}, \frac{7}{120}$
6. $\frac{111}{1232}, \frac{111}{1344}, \frac{111}{1680}, \frac{111}{1904}$
7. $\frac{131}{1980}, \frac{131}{2376}, \frac{131}{2508}, \frac{131}{2772}$
8. $\frac{113}{2961}, \frac{113}{3243}, \frac{113}{3525}, \frac{113}{3807}$
9. $\frac{99}{2400}, \frac{99}{2700}, \frac{99}{2800}, \frac{99}{3500}$
10. $\frac{210}{7596}, \frac{210}{8229}, \frac{210}{8651}, \frac{210}{10761}$

Exercise 47. (Page 105.)

1. $17\frac{5}{8}$; 169
2. $143\frac{7}{12}$; $457\frac{15}{18}$
3. $45\frac{2}{14}$; $48\frac{2}{19}$
4. $233\frac{13}{181}$
5. $1002\frac{304}{321}$
6. $1006\frac{206}{413}$
7. $998\frac{39}{791}$
8. $12316\frac{205}{261}$
9. $131\frac{2185}{3256}$
10. $1284\frac{1875}{3214}$

Exercise 48. (Page 106.)

1. $\frac{19}{6}$; $\frac{39}{8}$
2. $\frac{1623}{7}$
3. $\frac{14690}{3}$
4. $\frac{82103}{12}$
5. $\frac{2253906}{7}$
6. $\frac{27727}{13}$
7. $\frac{1298218}{15}$
8. $\frac{36093}{168}$
9. $\frac{513304}{231}$
10. $\frac{7208256}{811}$

Exercise 49. (Page 106.)

1. $\frac{3}{11}$; $\frac{43}{88}$
2. $\frac{263}{277}$; $\frac{4}{7}$
3. $\frac{5}{8}$; $\frac{20}{21}$
4. $\frac{29}{31}$; $\frac{1785}{3572}$
5. $\frac{2}{7}$; $\frac{29}{31}$
6. $\frac{43}{44}$; $\frac{68}{123}$
7. $\frac{101}{117}$; $\frac{5}{9}$
8. $\frac{9}{107}$; $\frac{13}{48}$
9. $\frac{15}{29}$; $\frac{7}{8}$
10. $\frac{316}{113}$; $\frac{5355}{7144}$

Exercise 50. (Page 107.)

1. $\frac{1}{6}$
2. $\frac{209}{12}$ or $17\frac{5}{12}$
3. $\frac{24}{35}$
4. $\frac{477}{2}$ or $238\frac{1}{2}$
5. 48
6. $\frac{2}{3}$
7. 1512
8. $\frac{655}{968}$
9. $\frac{26288}{245}$ or $107\frac{73}{245}$
10. $\frac{16}{7}$ or $2\frac{2}{7}$

Exercise 51. (Page 108.)

1. $\frac{30\,.\,20\,.\,15\,.\,12}{60}$
2. $\frac{2079\,.\,1980\,.\,1925\,.\,1890}{3465}$
3. $\frac{210\,.\,255\,.\,108\,.\,170}{390}$
4. $\frac{30\,.\,45\,.\,50\,.\,96}{510}$
5. $\frac{240\,.\,225\,.\,228\,.\,290}{660}$
6. $\frac{2808\,.\,3375\,.\,3900}{17550}$
7. $\frac{3230\,.\,3240\,.\,3249}{3420}$
8. $\frac{224\,.\,225\,.\,170}{240}$
9. $\frac{560\,.\,441\,.\,912}{4032}$
10. $\frac{60\,.\,525\,.\,1974}{3220}$

Exercise 52. (Page 108.)

(*The fractions are placed in order of magnitude—the largest first.*)

1. $\frac{3}{8}$, $\frac{4}{11}$, $\frac{1}{3}$
2. $\frac{4}{9}$, $\frac{3}{7}$, $\frac{2}{5}$
3. $\frac{20}{21}$, $\frac{15}{16}$, $\frac{13}{14}$
4. $\frac{17}{18}$, $\frac{11}{12}$, $\frac{6}{7}$
5. $\frac{6}{7}$, $\frac{5}{6}$, $\frac{4}{5}$
6. $\frac{11}{13}$, $\frac{9}{11}$, $\frac{7}{9}$
7. $\frac{13}{25}$, $\frac{22}{45}$, $\frac{17}{35}$
8. $\frac{5}{21}$, $\frac{4}{17}$, $\frac{7}{34}$
9. $\frac{5}{26}$, $\frac{4}{21}$, $\frac{3}{16}$
10. $\frac{19}{20}$, $\frac{18}{19}$, $\frac{17}{18}$

ADDITION, &c., OF VULGAR FRACTIONS.

Exercise 53. (Page 112.)

1. 1
2. $8\frac{296}{315}$
3. $11\frac{8}{21}$
4. $5\frac{1}{3}$
5. 4
6. $39\frac{2}{3}$
7. 12
8. 1
9. $6\frac{53}{56}$
10. $7\frac{17}{40}$
11. $8\frac{11}{18}$
12. $10\frac{41}{72}$
13. $9\frac{10}{21}$
14. $1\frac{59}{60}$
15. 5
16. $\frac{14}{15}$
17. $1\frac{9}{20}$
18. $16\frac{9}{20}$
19. $2\frac{1613}{3400}$
20. $28\frac{9}{40}$
21. $4\frac{57}{140}$
22. $1\frac{7}{9}$
23. $4\frac{67}{90}$
24. $13\frac{5}{8}$
25. $12\frac{5}{8}$
26. $\frac{19}{28}$
27. $3\frac{54}{55}$
28. $8\frac{16}{21}$
29. $1\frac{7}{90}$
30. $8\frac{51}{56}$
31. $\frac{1}{154}$
32. $-\frac{4}{15}$
33. $-\frac{1}{60}$
34. $\frac{1}{3}$
35. $\frac{11}{12}$
36. $3\frac{29}{30}$
37. $3\frac{27}{40}$
38. $\frac{47}{48}$
39. $5\frac{137}{266}$
40. $15\frac{17}{36}$

Exercise 54. (Page 113.)

1. 100
2. 415
3. 30
4. $3\frac{1}{8}$
5. 2
6. $\frac{13}{27}$
7. $8\frac{1}{4}$
8. $30\frac{1}{3}$
9. $11\frac{2}{5}$
10. $81\frac{3}{7}$
11. 13
12. $35\frac{5}{7}$
13. $\frac{9}{43}$
14. $\frac{1}{6}$
15. $4\frac{1}{5}$
16. $2\frac{170}{231}$
17. $24\frac{16}{21}$
18. $1\frac{6}{7}$
19. $16\frac{97}{1800}$
20. $\frac{2}{125}$

Exercise 55. (Page 114.)

1. $2\frac{4}{5}$
2. $\frac{3}{8}$
3. $7\frac{6}{19}$
4. $2\frac{1}{2}$
5. $1\frac{5}{21}$
6. $9\frac{9}{80}$
7. $6\frac{2}{3}$
8. 30
9. $2\frac{3}{11}$
10. $5\frac{35}{107}$
11. $46\frac{2}{3}$
12. 76
13. $1\frac{1}{60}$
14. $7\frac{41}{60}$
15. $5\frac{19}{30}$

Exercise 56. (Page 114.)

1. $\frac{2}{75}$
2. $\frac{3}{38}$
3. $\frac{14}{75}$
4. $\frac{6}{23}$
5. $\frac{2}{75}$
6. $\frac{1}{1008}$
7. $\frac{1}{45}$
8. $\frac{1}{550}$
9. $\frac{1}{28560}$
10. $\frac{1}{60}$

Exercise 57. (Page 115.)

1. 1
2. 12
3. 1260
4. 4080
5. 140
6. $43\frac{1}{5}$
7. $38\frac{8}{9}$
8. $183\frac{3}{4}$
9. $17\frac{5}{11}$
10. $23\frac{4}{7}$

Exercises on Complex Fractions. (Page 116.)

1. 2
2. 12
3. $\frac{5}{81}$
4. $4\frac{1}{6}$
5. $\frac{1}{2}$
6. $\frac{95}{737}$
7. $\frac{159}{3146}$
8. 1
9. $2\frac{11}{18}$
10. 1
11. $3\frac{1}{2}$
12. 4
13. $1\frac{513}{1225}$
14. $\frac{1}{8}$
15. 1
16. $4\frac{1}{6}$
17. 2
18. 8
19. 2
20. 2
21. 2
22. 5
23. $17\frac{1}{2}$
24. 1
25. $\frac{11}{12}$
26. 1
27. 1
28. 1
29. 6
30. 1
31. 1
32. 1
33. $\frac{1}{3}$
34. $1\frac{140}{549}$
35. $\frac{1125}{5117}$
36. 1
37. 1
38. 2
39. $-1\frac{567}{1398}$
40. $1\frac{17}{88}$
41. 1
42. $2\frac{24}{317}$

CROSS OR COMPLEX REDUCTION.

Exercise 58. (Page 119.)

1. 40 tons 3 cwts. 2 qrs. 8 lbs.
2. 4200 guineas.
3. 35280 moidores.
4. £6070386
5. £38683575
6. £1103214
7. £8154762
8. 4362000 guineas.
9. 4841820 guineas.
10. 24209100 guineas.

REDUCTION OF VULGAR FRACTIONS.

Exercise 59. (Page 120.)

1. 2
2. $\frac{1}{512}$
3. $\frac{1}{72}$
4. $\frac{10}{11}$
5. $\frac{1}{6}$
6. $\frac{4}{9}$
7. $\frac{421}{21120}$
8. $\frac{3}{128}$
9. $\frac{1}{880}$
10. $\frac{1}{64}$
11. $1\frac{1}{5}$
12. $\frac{3}{7040}$
13. 18*s.* $2\frac{1}{4}$*d.*
14. $\frac{1}{8}$
15. 5*s.* 6*d.*; $\frac{11}{42}$
16. £1, 16*s.*; £1, 16*s.* 10*d.*
17. 13*s.* 4*d.*
18. £2, 13*s.* 4*d.*
19. 5 yds. 0 ft. 9 in.
20. 18*s.* $8\frac{1}{4}$*d.* + $\frac{3}{5}$

DECIMAL FRACTIONS.

Exercise 60. (Page 122.)

1. ·3; ·0007; ·000012
2. ·4; ·144
3. ·48828125
4. ·2096
5. ·732421875
6. ·8145
7. ·897216796875
8. ·8192
9. ·0000512
10. ·91552734375

Exercise 61. (Page 122.)

1. $\frac{7}{80}$; $\frac{7}{8}$
2. $\frac{13}{40}$; $\frac{13}{4000}$
3. $\frac{5}{16}$; $\frac{1}{80}$
4. $\frac{5}{8}$; $\frac{1}{160}$
5. $\frac{49}{8000}$; $\frac{249}{400}$
6. $\frac{7}{80000}$; $\frac{63}{25000}$
7. $\frac{3}{800000000}$; $\frac{2}{3125}$
8. $\frac{63}{80}$; $\frac{1}{12500}$
9. $\frac{9}{8000}$; $\frac{189}{2500000}$
10. $\frac{2091}{250000000}$; $\frac{7}{1562500}$

Exercise 62. (Page 123.)

1. 825·41463
2. 518·3106
3. 145·07127
4. 35·877
5. 12514·47745
6. 228·7315
7. 6297·5554
8. 5317·5198
9. 192·90197
10. 169·59604
11. 37535·8406
12. 1899·67276
13. 16979·13434767
14. 90517·96474857
15. 84274·6317421

Exercise 63. (Page 124.)

1. 38·5108
2. 48·511
3. 123·42077
4. ·88093
5. 5·3263457
6. 146·49913055
7. ·05335
8. 1853·823396
9. 230·9919986
10. ·998899
11. ·099001
12. ·0000991
13. ·0000999
14. 4999·263999
15. 9999·99918548

Exercise 64. (Page 124.)

1. 106·5918
2. ·003
3. ·01653377
4. ·4206969
5. ·0000128
6. ·251
7. ·000080223
8. ·0020304
9. 1·173
10. ·0029808
11. ·0040804
12. 2400·6
13. ·00756
14. ·389464
15. ·113022
16. ·0100395
17. ·268975
18. 74·9265
19. ·00749265
20. ·0015
21. ·0756
22. 37·07724
23. ·82008
24. ·00001
25. 800
26. ·0000000156
27. ·0000405
28. ·000000001203
29. ·00000000002
30. ·0000000006012

Exercise 65. (Page 126.)

1. 125·0480
2. 1·1252
3. 597·2971
4. ·8586
5. ·1492
6. 69·8038
7. 1·1664
8. ·7315
9. 4·0073
10. 185·2935
11. ·1702
12. 18·2756
13. ·0276
14. ·0126
15. ·4337
16. ·0533
17. ·0668
18. ·0123
19. 3491·7595
20. ·0002

Exercise 66. (Page 126.)

1. 1·3
2. 19880
3. ·03
4. 45·8723 +
5. ·002215
6. 7500
7. ·603
8. 26987·1428 +
9. 3000
10. ·03
11. 3
12. 22500
13. 13; 130; ·013
14. ·00012
15. 3000
16. 408000
17. 43·47826 +
18. ·0864; 234·375
19. ·000016 +
20. 4444·4
21. 24600
22. 600600
23. 6·006
24. 545·6
25. ·0096; 9600
26. 800; ·08; 8
27. ·0004; 4000; 40
28. 130; 1·3; 130
29. 1·2; 240; 9
30. 8000; ·00125
31. 26·5841
32. ·000064
33. ·000000027
34. ·00000000147
35. 147000000000
36. ·00099
37. 990000000000
38. ·0000000000004
39. 400
40. ·0000028

Exercise 67. (Page 128.)

1. 16·0790
2. 3571·3252
3. 15·2865
4. 6·8821
5. ·0896
6. ·0526
7. 24·3073
8. ·0421
9. 117·2282
10. 2·4671

REPEATING DECIMALS.

Exercise 68. (Page 129.)

1. $\frac{578}{99999}$; $\frac{367}{999}$
2. $\frac{8}{9}$; $\frac{2}{3}$; $\frac{5140}{9999}$
3. $\frac{3214}{9999}$; $\frac{1443}{11111}$
4. $\frac{79}{101}$; $\frac{43}{111}$
5. $\frac{1376}{11111}$; $\frac{82}{111}$
6. $\frac{1371742}{11111111}$
7. $\frac{4322}{10001}$
8. $\frac{337834}{1111111}$
9. $\frac{5001}{1111111}$
10. $\frac{3401}{111111}$

Exercise 69. (Page 130.)

1. $\frac{1}{88}$
2. $\frac{173}{550}$
3. $\frac{43}{8325}$
4. $\frac{1068971}{3330000}$
5. $\frac{121201}{999900}$
6. $\frac{48889}{90000}$; $\frac{1898219}{3330000}$
7. $\frac{19447}{45000}$; $\frac{225233}{247500}$
8. $\frac{15991}{49950}$; $\frac{17782}{83325}$
9. $\frac{80243}{249975}$; $\frac{355709}{499500}$
10. $\frac{613}{16500}$; $\frac{53081}{249975}$

Exercise 70. (Page 131.)

1. 2407·954532
2. 58·785815
3. 103·302456
4. 923·703334
5. 69·597947
6. 159·607806
7. 4·203575
8. 34·871717
9. 47·617511
10. 3·433010

Exercise 71. (Page 133.)

1. $5{\cdot}\dot{8}\dot{1}$
2. $\cdot\dot{0}0\dot{7}$
3. $\cdot 0270\dot{4}\dot{5}$
4. 8·8
5. 5·6
6. $\cdot 0\dot{7}9\dot{2}$
7. $1{\cdot}\dot{2}6373\dot{6}$
8. ·075
9. ·012484
10. ·026744

REDUCTION OF DECIMALS.

Exercise 72. (Page 135.)

1. ·0645
2. ·1197
3. ·1729
4. ·2489
5. ·2937
6. ·3364
7. ·3916
8. ·4385
9. ·4875
10. ·5114
11. ·5989
12. ·6354
13. ·6823
14. ·7343
15. ·775
16. ·8312
17. ·8666
18. ·9406
19. ·9583
20. ·9989

Exercise 73. (Page 136.)

	s.	d.		s.	d.		s.	d.		s.	d.		s.	d.
1.	0	2¾	7.	4	4	13.	8	1¾	19.	12	2½	25.	16	1
2.	1	7¼	8.	5	5¾	14.	8	8¼	20.	12	9	26.	16	9½
3.	1	11½	9.	5	10	15.	9	5	21.	13	0¼	27.	17	8
4.	2	10	10.	6	1¾	16.	9	9¾	22.	13	7	28.	18	3¾
5.	3	5	11.	6	9½	17.	10	10	23.	14	5¼	29.	18	9½
6.	3	10¼	12.	7	7½	18.	11	11¾	24.	15	11¼	30.	19	9¼

MISCELLANEOUS QUESTIONS IN DECIMALS.

(Page 137.)

1. ·06875
2. ·068965
3. 2*s.* 3½*d.*
4. $\cdot 6805397\dot{7}\dot{2}$
5. $\cdot 02\dot{6}$
6. $\cdot 41\dot{6}$
7. ·001953125
8. 3 qrs. 7 lbs.
9. $\cdot 013\dot{8}$
10. $4\cdot 632\dot{9}3650\dot{7}$
11. 14 ac. 20 po. 12 yds. 129$\frac{3}{5}$ inches.
12. $\cdot 82886\dot{9}0476\dot{1}$
13. £1, 5*s.* 0¾*d.*·0012
14. 2 miles 2 fur. 33 po. 2 ft. 2 inches.
15. 1·325
16. ·119140625
17. $\cdot 1\dot{6}$
18. ·38390625
19. $\cdot 86\dot{3}$
20. ·00875
21. $\cdot 4\dot{8}$
22. 1·224
23. ·23125
24. 14*s.* 9*d.*
25. ·0234375
26. $\cdot 001\dot{3}\dot{6}$
27. 3 tons 7 cwts. 3 qrs. 22 lbs.
28. 18*s.* 9*d.*; ·875
29. 1 lb.
30. Both = 7*s.* 6*d.*
31. $\frac{28}{5}$ or 5$\frac{3}{5}$
32. $\frac{3}{8}$; $\frac{3}{80}$; $\frac{3}{275}$
33. $13\cdot 1349\dot{3}$
34. 562·1 or 562$\frac{1}{10}$
35. 2665
36. ·3125
37. $\frac{210}{743}$ or ·2826 +
38. 16*s.* 4$\frac{2}{5}$*d.*; 16*s.* 4$\frac{4}{11}$*d.*; 16*s.* 4$\frac{8}{25}$*d.*; or as 27005 to 27000 to 26994
39. $1\cdot\dot{3}$
40. 1·2130375
41. £4, 15*s.* 9¾*d.*; ·0046875
42. ·2685546875
43. ·095
44. 7 times.
45. 390·625

COMMERCIAL ARITHMETIC.

SIMPLE PRACTICE.

Exercise 74. (Page 141.)

1.

£	s.	d.
6172	10	0
4115	0	0
3086	5	0
2469	0	0
2057	10	0

2.

£	s.	d.
33945	10	0
22630	6	8
16972	15	0
13578	4	0
11315	3	4

3.

£	s.	d.
11728	0	0
7818	13	4
5864	0	0
4691	4	0
3909	6	8

4.

£	s.	d.
39456	0	0
26304	0	0
19728	0	0
15782	8	0
13152	0	0

5.

£	s.	d.
17283	10	0
11522	6	8
8641	15	0
6913	8	0
5761	3	4

6.

£	s.	d.
11140	7	6
8912	6	0
7426	18	4
5941	10	8
5570	3	9
4456	3	0

7.

£	s.	d.
5709	15	0
4567	16	0
3806	10	0
3045	4	0
2854	17	6
2283	18	0

8.

£	s.	d.
11404	5	0
9123	8	0
7602	16	8
6082	5	4
5702	2	6
4561	14	0

9.

£	s.	d.
7098	12	6
5678	18	0
4732	8	4
3785	18	8
3549	6	3
2839	9	0

10.

£	s.	d.
12345	12	6
9876	10	0
8230	8	4
6584	6	8
6172	16	3
4938	5	0

11.

£	s.	d.
1080	9	6
720	6	4
540	4	9
360	3	2
270	2	4½
180	1	7
90	0	9½
45	0	4¾

12.

£	s.	d.
2191	7	0
1460	18	0
1095	13	6
730	9	0
547	16	9
365	4	6
182	12	3
91	6	1½

13.

£	s.	d.
804	19	0
536	12	8
402	9	6
268	6	4
201	4	9
134	3	2
67	1	7
33	10	9½

14.

£	s.	d.
1913	11	6
1275	14	4
956	15	9
637	17	2
478	7	10½
318	18	7
159	9	3½
79	14	7¾

15.

£	s.	d.
549	13	6
366	9	0
274	16	9
183	4	6
137	8	4½
91	12	3
45	16	1½
22	18	0¾

16.

£	s.	d.
54526	13	4
49074	0	0
45802	8	0
43621	6	8
40895	0	0

17.

£	s.	d.
16563	6	8
14907	0	0
13913	4	0
13250	13	4
12422	10	0

18.

£	s.	d.
45267	10	0
40740	15	0
38024	14	0
36214	0	0
33950	12	6

19.

£	s.	d.
83239	3	4
74915	5	0
69920	18	0
66591	6	8
62429	7	6

20.

£	s.	d.
63879	3	4
57491	5	0
53658	10	0
51103	6	8
47909	7	6

21.

£	s.	d.
26599	4	0
25860	6	8
25121	9	4
24936	15	0
24382	12	0
24013	3	4

22.

£	s.	d.
12719	8	0
12366	1	8
12012	15	4
11924	8	9
11659	9	0
11482	15	10

23.

£	s.	d.
53265	12	0
51786	0	0
50306	8	0
49936	10	0
48826	16	0
48087	0	0

24.

£	s.	d.
29494	16	0
27310	0	0
24579	0	0
22940	8	0
20755	12	0
20482	10	0

25.

£	s.	d.
14949	9	0
13842	1	8
12457	17	6
11627	7	0
10519	19	8
10381	11	3

26.

£	s.	d.
8994	12	0
8328	6	8
7495	10	0
6995	16	0
6329	10	8
6246	5	0

27.

£	s.	d.
23299	10	0
21034	5	5
20710	13	4
20387	1	3
22063	9	2

28.			29.			30.		
£	s.	d.	£	s.	d.	£	s.	d.
16329	18	0	21013	1	0	93933	3	0
14742	5	5	19169	16	0	85693	8	0
14515	9	4	18248	3	6	81573	10	6
14288	13	3	17510	17	6	78277	12	6
14061	17	2	20644	8	0	92285	4	0

31.			32.			33.		
£	s.	d.	£	s.	d.	£	s.	d.
32722	7	8	21299	19	8	7723	14	3
31058	10	8	20216	18	8	7123	16	3
27730	16	8	18050	16	8	4524	4	11
26066	19	8	16967	15	8	5124	2	11
25789	13	6	16787	5	6	5574	1	5

34.			35.			36.		
£	s.	d.	£	s.	d.	£	s.	d.
56499	7	3	82702	9	6	48048	1	6
52111	1	3	81316	8	0	47242	16	0
33095	1	11	78544	5	0	45632	5	0
37483	7	11	101645	10	0	59053	10	0
40774	12	5	103493	12	0	60127	4	0

	£	s.	d.		£	s.	d.		£	s.	d.
37.	335	16	5¼	57.	5450	13	8½	77.	27604	8	9
38.	308	0	7	58.	4293	16	9	78.	3099	16	6
39.	654	14	9½	59.	7985	6	3	79.	12551	6	5
40.	688	2	1½	60.	6601	16	9	80.	1235	0	9
41.	940	17	7¼	61.	24206	17	0½	81.	4642	13	3
42.	8217	10	4	62.	18385	1	6¾	82.	12954	12	3¾
43.	5760	2	8½	63.	23925	17	3¾	83.	27686	10	2¼
44.	7427	5	9	64.	90208	11	4¼	84.	73001	17	1¾
45.	3431	15	8	65.	331244	6	4	85.	48439	12	5⅚
46.	14063	4	5½	66.	137487	0	4	86.	227375	10	4
47.	4642	13	3	67.	3627	8	4	87.	47804	9	3
48.	4318	4	1¼	68.	1535	12	9	88.	98463	15	5¼$\frac{3}{7}$
49.	683	12	3½	69.	2243	13	2	89.	98139	9	11⅗
50.	2369	10	8¼	70.	2817	13	4	90.	18041	14	3¼
51.	2365	3	11½	71.	7364	0	0	91.	55207	7	8½⅔
52.	1171	13	4½	72.	2265	1	9	92.	15276	6	8¼$\frac{7}{9}$
53.	1287	6	11	73.	1033	13	11½	93.	118092	13	7
54.	2412	5	8¼	74.	1829	13	7¾	94.	570001	15	6$\frac{5}{11}$
55.	3296	5	0½	75.	4830	2	7½	95.	13300451	6	8
56.	7715	6	11½	76.	9678	16	1¾	96.	240502029	5	7¾

COMPOUND PRACTICE.

Exercise 75. (Page 144.)

	£	s.	d.		£	s.	d.		£	s.	d.
1.	4480	14	$8\frac{1}{4}$	13.	13	9	$0\frac{3}{4}$	25.	502	6	$10\frac{1}{2}$
2.	2493	4	$3\frac{27}{64}$	14.	33	16	$7\frac{1}{4}$	26.	36	10	$2\frac{1}{4}$
3.	281	4	$5\frac{7}{10}$	15.	20	7	$9\frac{3}{4}$	27.	71	15	0
4.	50	12	$6\frac{7}{16}$	16.	14069	10	$7\frac{1}{2}$	28.	110	17	$3\frac{17}{18}$
5.	204	14	$11\frac{3}{8}$	17.	2516	17	6	29.	13	5	$5\frac{85}{96}$
6.	160	6	$5\frac{1}{2}$	18.	26	17	$8\frac{1}{4}$	30.	529	0	$7\frac{1}{2}$
7.	92	7	$1\frac{5}{16}$	19.	5	1	0	31.	937	13	2
8.	485	5	$0\frac{3}{4}$	20.	3	14	9	32.	25	2	$3\frac{1}{2}$
9.	44	13	$4\frac{35}{48}$	21.	4	17	$10\frac{1}{2}$	33.	186	19	$9\frac{1}{4}$
10.	258	5	3	22.	13	19	$1\frac{1}{2}$	34.	781	5	$2\frac{1}{2}$
11.	85	10	$11\frac{1}{2}$	23.	36	4	6	35.	143 qrs. 7 bus. $3\frac{27}{64}$ pks.		
12.	1350	14	$0\frac{3}{4}$	24.	0	3	$7\frac{3}{4}$				

VARIATION.

Exercise 76. (Page 148.)

1. 11 hrs.
2. 15 men.
3. 2*s*. 4*d*.
4. £835, 13*s*. $1\frac{1}{2}$*d*.
5. 28 horses.
6. 4lbs. 1oz. 9dwts. $22\frac{106}{125}$ grs.
7. £50
8. £7700
9. 44 sacks.
10. 11 days.
11. £26, 10*s*.
12. £19, 14*s*. $1\frac{1}{2}$*d*.
13. £48, 16*s*. $4\frac{2}{13}$*d*.
14. £810, 12*s*. 6*d*.
15. 8 days.
16. 4 days.
17. £31, 5*s*.
18. 34 chests.
19. 28 horses.
20. 90 navvies.
21. 18 days.
22. 10 hours.
23. 2 days.
24. 21 days.
25. £2, 5*s*. 9*d*.
26. 12 days.
27. 96 days.
28. 18 men.
29. 14 persons.
30. 15 men.
31. 5 hours.
32. 15 men.
33. £51, 4*s*. $3\frac{1}{2}$*d*.
34. 108 men.
35. £33, 1*s*. 6*d*.
36. $9\frac{103}{183}$ days.
37. 108 miles.
38. 81 men.
39. £21, 7*s*. 6*d*.
40. 21 weeks.
41. £7, 10*s*.
42. 45 weeks.
43. 6 days.
44. 660 men.
45. £1, 0*s*. $1\frac{1}{2}$*d*.
46. 9 men.
47. 14 men.
48. 21 days.
49. £48
50. £1, 6*s*. $9\frac{3}{4}$*d*.
51. £8
52. 8 days.
53. £3050, 15*s*. 6*d*.
54. £50
55. 181 ac. 1 ro $30\frac{2}{5}$ po.
56. $20\frac{1280}{3101}$ hours.
57. £107, 8*s*. 9*d*.
58. $4\frac{1}{2}$ miles.
59. 34 qrs. 3 bus. 2 pks.
60. 31 qrs. 2 bus.
61. 9 days.
62. 2 men.
63. 16 days.
64. 1980 yards.
65. $12\frac{8}{9}$ hours.
66. 132 days.

SIMPLE INTEREST.

Exercise 77. (Page 153.)

	£	s.	d.		£	s.	d.		£	s.	d.
1.	897	7	$1\frac{1}{2}$	11.	475	15	3	21.	885	12	7·93125
2.	124	6	3	12.	495	14	$2\frac{19}{40}$	22.	33	1	$2\frac{2}{5}$
3.	66	15	$5\frac{61}{400}$	13.	128	12	6	23.	65	19	6
4.	40	13	$4\frac{1}{2}$	14.	450	0	0	24.	289	5	$7\frac{4}{5}$
5.	45	2	6	15.	72	9	$7\frac{21}{25}$	25.	38	14	$11\frac{17}{20}$
6.	11	5	0	16.	1296	1	0	26.	220	5	$1\frac{1}{5}$
7.	265	12	$11\frac{1}{4}$	17.	749	2	0	27.	216	0	0
8.	445	5	10	18.	603	1	$6\frac{1}{4}$ +	28.	226	13	1
9.	1	5	0	19.	170	5	0 +	29.	171	0	1
10.	21	17	6	20.	995	10	0	30.	977	5	$4\frac{4}{5}$

Exercise 78. (Page 155.)

	£	s.	d.		£	s.	d.		£	s.	d.
1.	1	4	$7\frac{3}{4}$	8.	333	6	$8\frac{3}{4}$	15.	15	4	$2\frac{1}{2}$
2.	145	13	$5\frac{3}{4}$	9.	55	11	$1\frac{3}{4}$	16.	724	16	$4\frac{3}{4}$
3.	870	13	$1\frac{3}{4}$	10.	777	3	$5\frac{3}{4}$	17.	1888	12	$11\frac{3}{4}$
4.	99	17	$9\frac{1}{4}$	11.	405	15	10	18.	3521	9	$9\frac{1}{4}$
5.	801	11	$6\frac{3}{4}$	12.	0	1	$8\frac{1}{4}$	19.	244	1	2
6.	24	13	$8\frac{1}{2}$	13.	0	7	$4\frac{1}{2}$	20.	1080	14	$1\frac{1}{2}$
7.	1015	0	$2\frac{1}{2}$	14.	4	11	$5\frac{3}{4}$				

Exercise 79. (Page 156.)

	£	s.	d.		£	s.	d.		£	s.	d.
1.	16	18	$2\frac{3}{4}$	9.	135	5	$10\frac{3}{4}$	18.	98	14	$1\frac{3}{4}$
2.	32	2	$7\frac{3}{4}$	10.	30	2	$4\frac{3}{4}$	19.	3	3	$5\frac{1}{4}$
3.	47	7	$0\frac{3}{4}$	11.	59	3	$10\frac{1}{4}$	20.	65	12	$1\frac{1}{2}$
4.	62	11	$5\frac{3}{4}$	12.	104	17	1	21.	71	14	$2\frac{1}{2}$
5.	77	15	$10\frac{1}{2}$	13.	120	1	$5\frac{3}{4}$	22.	27	3	$2\frac{1}{2}$
6.	93	0	$1\frac{1}{4}$	14.	82	17	$7\frac{1}{2}$	23.	72	9	$2\frac{3}{4}$
7.	108	2	$10\frac{3}{4}$	15.	75	19	0	24.	63	19	$1\frac{1}{4}$
8.	122	1	$8\frac{3}{4}$	16.	45	10	2	25.	1369	17	3
				17.	15	7	$5\frac{3}{4}$				

Exercise 80. (Page 156.)

	£	s.	d.		£	s.	d.		£	s.	d.
1.	750	0	0	4.	318	15	0	8.	945	10	0
2.	703	2	6	5.	98	15	10	9.	556	13	4
3.	516	11	$7\frac{1}{2}$	6.	236	6	8	10.	936	11	3
				7.	198	6	8				

Exercise 81. (Page 157.)

1.	9 %	3.	$3\frac{1}{8}$ %	5.	$10\frac{1}{2}$ %	7.	$4\frac{1}{2}$ %	9.	$5\frac{1}{2}$ %
2.	$3\frac{1}{8}$ %	4.	$3\frac{1}{3}$ %	6.	7 %	8.	50 %	10.	4 %

Exercise 82. (Page 158.)

1.	$6\frac{1}{2}$ yrs.	3.	$5\frac{1}{2}$ yrs.	5.	$2\frac{1}{2}$ yrs.	7.	$3\frac{1881}{1885}$ yrs.	9.	4 yrs.
2.	7 „	4.	7 „	6.	$2\frac{1}{2}$ „	8.	$4\frac{800}{959}$ „	10.	$8\frac{1}{2}$ „

Exercise 83. (Page 158.)

	£	s.	d.		£	s.	d.		£	s.	d.
1.	1000	0	0	4.	40	16	8	8.	631	6	$9\frac{37}{43}$
2.	175	0	0	5.	258	13	6	9.	369	0	0
3.	1423	14	$6\frac{54}{59}$	6.	90	13	4	10.	933	6	8
				7.	500	0	0				

Exercise 84. (Page 159.)

	£	s.	d.		£	s.	d.		£	s.	d.
1.	0	5	$5\frac{3}{4}$	11.	0	2	$10\frac{1}{2}$	21.	2	14	$9\frac{1}{2}$
2.	0	8	6	12.	0	6	$7\frac{1}{4}$	22.	6	16	$11\frac{3}{4}$
3.	0	9	$10\frac{1}{4}$	13.	0	7	$8\frac{1}{2}$	23.	10	1	$4\frac{1}{2}$
4.	0	11	$5\frac{1}{2}$	14.	0	15	$1\frac{1}{4}$	24.	20	1	$1\frac{1}{4}$
5.	0	13	$8\frac{1}{4}$	15.	0	18	3	25.	23	16	$5\frac{1}{4}$
6.	0	16	$5\frac{1}{4}$	16.	1	14	$4\frac{1}{4}$	26.	11	16	$9\frac{1}{2}$
7.	0	19	$2\frac{1}{4}$	17.	1	11	$1\frac{1}{4}$	27.	8	16	$1\frac{3}{4}$
8.	1	1	$3\frac{3}{4}$	18.	1	17	9	28.	5	17	$5\frac{1}{2}$
9.	2	1	$9\frac{1}{2}$	19.	2	0	0	29.	216	6	$8\frac{3}{4}$
10.	1	17	$5\frac{3}{4}$	20.	2	14	$1\frac{1}{2}$	30.	149	16	$0\frac{3}{4}$

DISCOUNT AND PRESENT WORTH.

Exercise 85. (Page 160.)

	£	s.	d.		£	s.	d.		£	s.	d.
1.	5000	0	0	5.	311	0	$1\frac{31}{209}$	9.	1430	14	7
2.	295	16	8	6.	1372	12	$2\frac{2}{7}$	10.	792	15	0
3.	450	0	0	7.	500	0	0	11.	9200	0	0
4.	800	0	0	8.	1780	0	0	12.	693	10	0

Exercise 86. (Page 161.)

	£	s.	d.
1.	0	7	8
2.	0	18	$2\frac{131}{821}$
3.	38	8	0
4.	0	18	$2\frac{2}{11}$
5.	29	3	4
6.	23	2	$4\frac{1}{2}$
7.	12	18	9
8.	16	18	$7\frac{3}{4}$
9.	2169	0	0
10.	161	5	0

CHAIN RULE AND BARTER.

Exercise 87. (Page 163.)

1. $2\frac{2}{3}$ lbs.
2. 84 eggs.
3. 60 gallons.
4. £2, 16*s.*
5. 112 lbs.
6. 3 lbs.
7. £12
8. 256 yards.
9. $981\frac{1}{3}$ thalers.
10. 9425 ponies.
11. 20 gulden.

EXCHANGE.

Exercise 88. (Page 165.)

1. £1 = 25·92 francs.
2. 122 florins.
3. 100 gulden.
4. $62\frac{1}{2}$ nearly.
5. £1 = 25·22 francs.
6. £1050
7. $539\frac{7}{10}$ Austrian lire.
8. £1, 19*s.* $4\frac{56}{127}$*d.*
9. £2, 3*s.* $2\frac{52774}{85007}$*d.* gain.
10. £11, 5*s.* gain.

FELLOWSHIP (SIMPLE).

Exercise 89. (Page 167.)

1. A's = £350; B's = £450.
2. A = £1228; B = £1542.
3. £360; £144; £240.
4. £503, 8*s.*; £587, 6*s.*; £671, 4*s.*
5. A has to pay B 7*s.* 1*d.*
6. A = £210, B = £150, C = £180.
7. A = £18,400, B = £12,266$\frac{2}{3}$.

FELLOWSHIP (COMPOUND).

Exercise 90. (Page 169.)

1. A = £62, 14*s.* $6\frac{6}{11}$*d.*; B = £50, 3*s.* $7\frac{7}{11}$*d.*; C = £25, 1*s.* $9\frac{9}{11}$.
2. A = £1, 10*s.* 0*d.*; B = £1, 16*s.* $6\frac{3}{4}$*d.*; C = £2, 5*s.* $11\frac{1}{4}$*d.*
3. A = £22, 13*s.* 4*d.*; B = £23, 13*s.* 4*d.*; C = £23, 6*s.* 8*d.*
4. A = £94, 10*s.* 0*d.*; B = £168; C = £396.
5. A = £34, 18*s.* $7\frac{1}{2}$*d.*; B = £46, 1*s.* $4\frac{1}{2}$*d.*
6. £179, 1*s.* 4*d.* and £257, 8*s.* 2*d.*

STOCKS.

Exercise 91. (Page 173.)

1. $4\frac{211}{400}d.$ increase.
2. £1350; $3\frac{1}{3}$ °/o
3. £78
4. The former by $\frac{1}{114}$ °/o
5. £140; £$98\frac{2}{15}$
6. Neither; both yield same.
7. Stocks = £16, 13s. 4d.; S.I. = £15
8. £$91\frac{1}{2}$
9. £$15\frac{1}{2}$ increase.
10. $5\frac{5}{14}$ °/o
11. £$864\frac{1}{2}$; £$892\frac{7}{10}$.
12. Unchanged.
13. £3600; £126
14. £2, 1s. 8d.
15. £60 increase.
16. £1078, 16s.
17. £75 decrease.
18. £107
19. £$1738\frac{1}{38}$.
20. £818, 8s.
21. £7430
22. £80
23. The 4 per cents; £13,704, 16s. $4\frac{52}{83}d.$
24. Both = £11, 5s. $6\frac{3}{4}d.$
25. £49 yearly.
26. £107, 14s. 2d.
27. £17, 17s. $1\frac{5}{7}d.$ yearly increase.
28. £5 loss.
29. £130
30. £14,520
31. £90
32. £$127\frac{1}{2}$
33. £$4\frac{1}{6}$ °/o
34. £1600 yearly.
35. £$2890\frac{1}{2}$
36. The 5°/o; £1, 19s. $4\frac{21352}{35209}d.$
37. £174,735
38. $2\frac{13}{31}$ °/o
39. 10 °/o
40. £343 loss; £45, 15s. increase.

PROFIT AND LOSS.

Exercise 92. (Page 177.)

1. 4s. 8d.
2. £79, 9s. $3\frac{3}{10}d.$
3. 5 °/o loss.
4. One-third of a quart.
5. £11, 2s. $2\frac{2}{3}d.$
6. £24
7. £25; $9\frac{1}{11}$ °/o
8. £225
9. $27\frac{1}{2}$ °/o gain.
10. £88, 11s.
11. £25 °/o gain.
12. $33\frac{1}{3}$ °/o
13. $26\frac{2}{3}$ °/o
14. £3, 6s. 8d.
15. £705, 10s.
16. 25 °/o; $12\frac{1}{2}$ °/o
17. 10 °/o; £2, 2s.
18. £2, 6s. 8d.; 20 °/o
19. 7s. $8\frac{1}{2}d.$
20. 18·94 °/o
21. $1\frac{29}{71}$ °/o
22. £40
23. £10
24. 415 lbs.
25. £3780

EQUATION OF PAYMENTS.

Exercise 93. (Page 180.)

1. £782, 14*s.* $6\frac{6}{11}$*d.*
2. 5·7 months.
3. £581, 3*s.* $9\frac{5}{7}$*d.*
4. $4\frac{5}{14}$ months.
5. 4 months 25 days.
6. $7\frac{7}{18}$ months.
7. $12\frac{1}{5}$ months.
8. $8\frac{2}{7}$ months.

TARE AND TRET.

Exercise 94. (Page 181.)

1. 4 cwts. $5\frac{3}{8}$ lbs.
2. 6 cwts. $3\frac{5}{7}$ lbs.
3. 1 cwt. 3 qrs. $7\frac{1}{13}$ lbs.
4. 9 cwts. 3 qrs. $26\frac{4}{7}$ lbs.
5. 82 cwts. 2 qrs. $12\frac{6}{7}$ lbs.
6. 100 cwts. 2 qrs. $3\frac{6}{7}$ lbs.
7. 5 cwts. 3 qrs. 1 lb.
8. 154 cwts. 3 qrs. 2 lbs.
9. 6 tons 9 cwts. 2 qrs. $17\frac{3}{7}$ lbs.
10. 4 tons 7 cwts. 2 qrs. $26\frac{12}{13}$ lbs.

ALLIGATION.

Exercises 95 and 96. (Page 183.)

1. $5\frac{5}{8}$*d.* per lb., or £2, 12*s.* 6*d.* per cwt.
2. 1*s.* $7\frac{1}{2}$*d.*
3. £10, 16*s.* $3\frac{1}{4}$*d.*, or 2*s.* $4\frac{77}{368}$*d.* per lb.
4. 7 and 2.
5. 1 and 3.
6. 3,5,4,2; or 2,4,5,3; or 5,9,9,5.
7. The mixture must cost or be worth 2*s.* $3\frac{1}{5}$*d.* per lb. and the qnantities either (1) 28 at 3*d.*, 73 at 2*s.* 3*d.*, 242 at 2*s.* 6*d.*, and 2 at 2*s.* $10\frac{1}{2}$*d.*; or (2) 73 at 3*d.*, 28 at 2*s.* 3*d.*, 2 at 2*s.* 6*d.*, and 242 at 2*s.* $10\frac{1}{2}$*d.*
8. 3 lbs. of first and 2 lbs. of second.
9. 3 and 13
10. 5 and 1
11. $22\frac{1}{2}$, 9, 18, $31\frac{1}{2}$; or 9, $22\frac{1}{2}$, $31\frac{1}{2}$, 18
12. 5, 3, 3 bushels.

POSITION.

Exercise 97. (Page 185.)

1. A £300, B £600, C £1800, and D £2700
2. Horse £13, 6*s.* 8*d.*, harness £6, 13*s.* 4*d.*, chaise £40
3. £120
4. 60 marbles.
5. £312, 10*s.*
6. 7500 men.
7. 75 gallons.
8. £45
9. 168
10. A £30, B £33, C £37
11. 84 feet.
12. 24
13. £120 first horse, £90 second horse.

Exercise 98. (Page 188.)

1. A £316, B £273, C £191
2. A £30, B £33, C £37
3. 14 orphans.
4. B 27 and C 36
5. 84
6. 24 feet.
7. A £200, B £300, C £5
8. 65*s*. and 15 persons.
9. 25 gals. at 9*s*. and 75 at 1
10. 72 inches.

ANNUITIES.

Exercises 99-101. (Page 190.)

(*Decimals of a farthing are not given*).

1. £3281, 14*s*. 6·3678*d*.
2. £2597, 7*s*. 3·38*d*.
3. £964, 5*s*. 4*d*.
4. £1402, 18*s*. 3·84*d*.
5. £2800.
6. £2029, 8*s*. 11·748*d*.
7. £6017, 1*s*. 7·22*d*.
8. Younger £1558, 2*s*. 9·04
   elder £7191, 17*s*. 2·95
9. £545, 10*s*.
10. £2000

SQUARE ROOT.

Exercise 102. (Page 193.)

1. 1039
2. 1016
3. 217
4. 47940
5. 23970
6. 999
7. 2922
8. 3443
9. 1234
10. 4701
11. 29897
12. 7130
13. 29496
14. 247009
15. 7014
16. 709
17. 1501
18. 31005
19. 100045
20. 10·30064
21. 9000·36
22. 410·0507
23. 60934298
24. 6214005
25. 7923008
26. ·632455
27. ·07071
28. $14\frac{1}{2}$; $3\frac{1}{11}$; $1\cdot\dot{3}$; 1·73205
29. $5\frac{4}{19}$; 16·067; 5·043
30. 5·9726; $\cdot\dot{6}$ or $\frac{2}{3}$; 24·01
31. 11001
32. 21022
33. 30594
34. 44004
35. 54302
36. 123045
37. 60507
38. 800905
39. 910901
40. 606066
41. 90807765
42. 990880789
43. 707000989
44. 111222033
45. 908007000

Exercise 103. (Page 194.)

1. 225
2. 625
3. 1225
4. 2025
5. 3025
6. 4225
7. 5625
8. 7225
9. 9025

Exercise 104. (Page 195.)

1. 15625
2. 50625
3. 105625
4. 180625
5. 275625
6. 390625
7. 525625
8. 680625
9. 855625

Exercise 105. (Page 195.)

1. 30625
2. 75625
3. 140625
4. 225625
5. 330625
6. 455625
7. 600625
8. 765625
9. 950625

Exercise 106. (Page 196.)

1. 12321
49284
110889
2. 1234321
4937284
11108889
3. 123454321
493817284
1111088889
4. 197136
308025
443556
5. 19749136
30858025
44435556
6. 603729
788544
998001
7. 60481729
78996544
99980001
8. 6049261729
7901076544
9999800001
9. 12345678787654321
49382715061728 4
10. 1111111088888889
1975308602469136
11. 3086419691358025
4444444355555556
12. 6049382595061729
7901234409876544
9999999998000000001

CUBE ROOT.

Exercise 107. (Page 198.)

1. 143
2. 201
3. 123
4. 405
5. 607
6. 809
7. 1023
8. 2034
9. 3045
10. 5406
11. 6507
12. 7008
13. 8009
14. 9111
15. 2193
16. 1$\frac{5}{14}$
17. 838·42
18. 132·5
19. 4·395 +
20. 90·09
21. 706·1
22. 3$\frac{2}{7}$
23. 1·794
24. 2·223
25. 3·43
26. 36$\frac{1}{6}$
27. 36$\frac{3}{13}$
28. ·6299
29. ·0982
30. ·00801
31. 125
32. 694
33. 721
34. 699
35. 856
36. 308
37. 795
38. 865
39. 372
40. 999
41. 1234
42. 4567
43. 7079
44. 8907
45. 5703
46. 9876
47. 876
48. 765
49. 6009
50. 3729

PROGRESSIONS (ARITHMETICAL).

Exercises 108 and 109. (Page 200.)

1. *a.* 970; *b.* 670; *c.* 3900; *d.* $57\frac{1}{2}$; *e.* 70; *f.* 440; *g.* 310
2. *a.* 5050; *b.* 5050
3. *a.* $52\frac{1}{2}$; *b.* $58\frac{1}{2}$; *c.* $297\frac{1}{2}$
4. *a.* 96; *b.* $6\frac{2}{3}$; *c.* $\frac{39}{2}$ or $19\frac{1}{2}$
5. $\frac{20}{41}$, $\frac{40}{41}$, $\frac{60}{41}$, $\frac{80}{41}$ - - - - $\frac{800}{41}$
6. $5\frac{3}{4}$, $8\frac{1}{2}$, $11\frac{1}{4}$, - - - - $44\frac{1}{4}$
7. 3, $3\frac{1}{2}$, 4, $4\frac{1}{2}$, + - - - - 17

(GEOMETRICAL).

Exercises 110 and 111. (Page 201·).

1. 15; $\frac{1}{2}$
2. 80, 20; $\frac{1}{4}$, $\frac{1}{2}$
3. 18, 54, 162
4. $6\frac{2}{5}$, 16, 40
5. $8\frac{3}{4}$
6. $4\frac{1}{6}$
7. $\frac{8}{21}$
8. 6, 18, 54, 162, 486, 1458, 4374
9. $1023\frac{3}{4}$
10. £204, 15*s.*

LOGARITHMS.

Exercise 112. (Page 203.)

1. 2·5453071
2. 2·6532125
3. 3·7050936
4. 3·5182507
5. 4·8295803
6. 4·9531070
7. 4·6023964
8. 4·3232521
9. 4·9365992
10. 4·4669862
11. 5·0915122
12. 5·3702670
13. 5·4829450
14. 5·7832459
15. 5·9547358
16. 6·9946050
17. 6·9581196
18. 6·7024331
19. 6·3421789
20. 6·9999516

Exercise 113. (Page 204.)

1. 150
2. 198
3. 2460
4. 30·9
5. 365
6. 4130
7. 50·8
8. 631
9. 7950
10. 990
11. 11·962
12. 141·57
13. 1661·5
14. 19953
15. 25·119
16. 3·2479
17. 0·4325835
18. ·054326
19. ·0063096
20. ·00079433

Exercise 114. (Page 205.)

1. 161160
2. 31744
3. 417746
4. 183546
5. 29250
6. 547944
7. 421728
8. 93251
9. 8611
10. 70·59259
11. 428
12. 1·876543
13. 1
14. ·8094059
15. 7·464816

Exercise 115. (Page 206.)

1. 1860867
2. 92416
3. 207·6481
4. 941192
5. 487·9681
6. 25010001
7. 451·0044
8. 675·4384
9. 95·21534
10. 83·21477
11. 30·33875
12. 10·43043

COMPOUND INTEREST.

Exercise 116. (Page 208.)

	£	s.	d.
1.	11	12	7
2.	9	5	$10\frac{4}{5}$
3.	391	13	$7\frac{1}{5}$
4.	141	3	$3\frac{3}{4}$·456
5.	295	0	11·04
6.	258	12	$1\frac{4}{5}$
7.	190	0	$1\frac{1}{4}$·92572
8.	50	12	6
9.	102	2	6
10.	352	18	$3\frac{27}{40}$
11.	590	1	10·08
12.	156	4	$10\frac{7}{80}$
13.	45	7	$9\frac{1}{2}$·28306
14.	9	12	$2\frac{23}{32}$
15.	10	18	$6\frac{18}{125}$
16.	1	1	$9\frac{36279}{256000}$

SCALES OF NOTATION

Exercise 117. (Page 210.)

1. ttt6929
2. 6e40383
3. 4t3159
4. 2023580000
5. 32e714
6. 560376
7. t0t0; 85488400
8. 100
9. 7t·141
10. 2483
11. 2151; 25; 25532
12. $10343655\frac{21}{22}$
13. 17325
14. 64122; 1964·e66
15. 56·6341 . . . .
16. 297456; 243·45; 804·069
17. 1e7566 2
18. 1001
19. 17 ft. $4\frac{1}{2}$ inches nearly.
20. 4769 c. ft. 10′ 11″ 4‴ or
    4769 c. ft. 1576 c. in.

MENSURATION AND DUODECIMAL ARITHMETIC.

Exercise 118. (Page 214.)

1. $275\frac{1}{2}$ yds.
2. 26 c. ft. $727\frac{5}{144}$ c. in.
3. $6\frac{1}{2}$ inches.
4. £20, 8*s.* $0\frac{4}{9}$*d.*

5. $3970\frac{7}{12}$
6. 28 c. ft. 3′ 5″ 10‴ 1⁗.
7. 46 c. ft. $298\frac{25}{48}$ in.
8. 34 c. ft. $1108\frac{31}{72}$ c. in.
9. 20 ft. 10′ 8″ 6‴.
10. 291 c. ft. $1099\frac{5}{9}$ c. in.
11. $69\cdot3\dot{2}\dot{1}$ yds.
12. 10*s.* $10\frac{2}{3}$*d.*
13. 10 sq. ft. $75\frac{139}{144}$ sq. in.
14. 299·6997 and 99·8999
15. £5, 5*s.*: £6, 17*s.* $4\frac{141}{1458}$*d.*

INVOICES AND COMMERCIAL ACCOUNTS.

(Page 217.)

	£	*s.*	*d.*
1.	229	13	$0\frac{3}{4}$
2.	12	14	3
3.	83	12	7
4.	270	12	6
5.	3	16	2
6.	5	8	$1\frac{1}{2}$
7.	4	18	$7\frac{1}{2}$
8.	134	3	$5\frac{1}{2}$
9.	34	17	2
10.	39	5	0
11.	26	1	$10\frac{1}{2}$
12.	32	5	1
13.	8	17	8
14.	17	18	$11\frac{1}{2}$
15.	1353	0	0
16.	42	14	2
17.	13	0	4
18.	108	16	$1\frac{1}{2}$
19.	117	12	0
20.	1274	8	0
21.	350	11	8
22.	19	15	9
23.	5	3	9
24.	23	6	0
25.	38	9	9
26.	46	14	8
27.	27	10	8

1. 6*s.* $0\frac{1}{2}$*d.*; £8, 6*s.* $6\frac{3}{4}$*d.*; 1*s.* $2\frac{1}{4}$*d.*; £1, 0*s.* $11\frac{5}{8}$*d.* Total, £9, 14*s.* $9\frac{1}{8}$*d.*
2. 1*s.* $11\frac{1}{16}$*d.*; 9*s.* $1\frac{1}{2}$*d.*; 5*s.* $10\frac{1}{3}$*d.*; 2*s.* $3\frac{1}{2}$*d.*; 10*s.* 6*d.* Total, £1, 9*s.* $8\frac{35}{48}$*d.*
3. £3, 11*s.* 3*d.*; £1, 4*s.* 6*d.*; 8*s.* 6*d.*; $3\frac{1}{2}$*d.*; 5*s.* $7\frac{1}{2}$*d.* Total, £5, 10*s.* 2*d.*
4. £2, 6*s.* 9*d.*; 18*s.* $6\frac{3}{4}$*d.*; £1, 14*s.* $1\frac{1}{2}$*d.*; £1, 7*s.* 6*d.* Total, £6, 6*s.* $11\frac{1}{4}$*d.*
5. 8*s.* 8*d.*; 2*s.* 6*d.*; 2*s.* $9\frac{3}{4}$*d.*; 1*s.* $0\frac{3}{4}$*d.* Total, 15*s.* $0\frac{1}{2}$*d.*
6. £4, 10*s.*; 14*s.* 8*d.*; £1, 9*s.* 2*d.*; £1, 1*s.*; 5*s.* 10*d.* Total, £8, 0*s.* 8*d.*
7. £3, 11*s.*; £1, 10*s.* $0\frac{3}{4}$*d.*; 3*s.* 3*d.*; 17*s.* $11\frac{1}{4}$*d.* Total, £6, 2*s.* 3*d.*
8. 19*s.* 3*d.*; £20, 10*s.*; £3, 14*s.* 9*d.* Total, £25, 4*s.*
9. £10, 3*s.* $5\frac{1}{4}$*d.*; 8*s.* $0\frac{3}{4}$*d.*; £1, 10*s.* $4\frac{1}{4}$*d.*; 11*s.* $8\frac{1}{4}$*d.* Total, £12, 13*s.* $6\frac{1}{2}$*d.*
10. 4*s.* 2*d.*; £1, 2*s.*; 10*s.* 8*d.*; 5*s.* 9*d.*; 3*s.* 9*d.*; 8*s.* 3*d.* Total, £2, 14*s.* 7*d.*
11. 12*s.* 6*d.*; 2*s.* 2*d.*; £303, 4*s.* $3\frac{11}{34}$*d.*; £3, 13*s.* 6*d.* Total, £307, 12*s.* $5\frac{11}{34}$*d.*

MENTAL ARITHMETIC.

Exercise 119. (Page 232.)

1. £12; £6; £3
2. 18; 9; 4, 10*s.*
3. 24; 12; 6
4. 30; 15; 7, 10*s.*
5. 36; 18; 9
6. 42; 21; 10, 10*s.*
7. 48; 24; 12
8. 54; 27; 13, 10*s.*
9. 8; 4; 2
10. 16; 8; 4
11. 20; 10; 5
12. 28; 14; 7
13. 32; 16; 8
14. 40; 20; 10
15. 44; 22; 11
16. 50; 25; 12, 10*s.*
17. 58; 29; 14, 10*s.*
18. 60; 30; 15
19. 66; 33; 16, 10*s.*
20. 72; 36; 18
21. 4; 2; 1
22. 6; 3; 1, 10*s.*
23. 8; 4; 2
24. 10; 5; 2, 10*s.*
25. 12; 6; 3
26. 14; 7; 3, 10*s.*
27. 16; 8; 4
28. 18; 9; 4, 10*s.*
29. 20; 10; 5
30. 22; 11; 5, 10*s.*
31. 24; 12; 6
32. 26; 13; 6, 10*s.*
33. 28; 14; 7
34. 30; 15; 7, 10*s.*
35. 32; 16; 8
36. 34; 17; 8, 10*s.*
37. 36; 18; 9
38. £38; £19; £9, 10*s.*
39. 40; 20; 10
40. 42; 21; 10, 10*s.*
41. 8; 4; 2
42. 12; 6; 3
43. 16; 8; 4
44. 20; 10; 5
45. 24; 12; 6
46. 28; 14; 7
47. 32; 16; 8
48. 36; 18; 9
49. 40; 20; 10
50. 44; 22; 11
51. 48; 24; 12
52. 52; 26; 13
53. 56; 28; 14
54. 60; 30; 15
55. 64; 32; 16
56. 68; 34; 17
57. 72; 36; 18
58. 76; 38; 19
59. 80; 40; 20
60. 84; 42; 21
61. 2
62. 2, 10*s.*
63. 3
64. 3, 10*s.*
65. 4
66. 4, 10*s.*
67. 5
68. 2
69. 3
70. 4
71. 5
72. 6
73. 7
74. 8

Exercise 120. (Page 233.)

1.	£10	4.	£50	7.	£60	10.	£110	13.	£140
2.	20	5.	80	8.	70	11.	100	14.	130
3.	40	6.	30	9.	90	12.	120	15.	150

Exercise 121. (Page 234.)

1.	£20;	£40	11.	£160;	£320	21.	£45;	£90
2.	30;	60	12.	200;	400	22.	55;	110
3.	40;	80	13.	220;	440	23.	65;	130
4.	60;	120	14.	230;	460	24.	85;	170
5.	70;	140	15.	240;	480	25.	95;	190
6.	80;	160	16.	25;	50	26.	105;	210
7.	100;	200	17.	50;	100	27.	120;	240
8.	130;	260	18.	75;	150	28.	135;	270
9.	90;	180	19.	125;	250	29.	155;	310
10.	140;	280	20.	150;	300	30.	170;	340

Exercise 122. (Page 235.)

1.	£5;	£10	6.	£30;	£60	11.	£120;	£240	16.	£90;	£180
2.	10;	20	7.	35;	70	12.	110;	220	17.	80;	160
3.	15;	30	8.	40;	80	13.	60;	120	18.	130;	260
4.	20;	40	9.	45;	90	14.	100;	200	19.	140;	280
5.	25;	50	10.	50;	100	15.	70;	140	20.	150;	300

Exercise 123. (Page 236.)

1.	£10;	£20;	£30;	£40;	£50
2.	12;	24;	36;	48;	60
3.	7;	14;	21;	28;	35
4.	8;	16;	24;	32;	40
5.	9;	18;	27;	36;	45
6.	11;	22;	33;	44;	55
7.	6;	12;	18;	24;	30
8.	5;	10;	15;	20;	25
9.	13;	26;	39;	52;	65
10.	14;	28;	42;	56;	70
11.	20;	40;	60;	80;	100
12.	30;	60;	90;	120;	150
13.	90;	180;	270;	360;	450
14.	40;	80;	120;	160;	200
15.	80;	160;	240;	320;	400
16.	70;	140;	210;	280;	350

17.	£60;	£120;	£180;	£240;	£300
18.	50;	100;	150;	200;	250
19.	55;	110;	165;	220;	275
20.	66;	132;	198;	264;	330

Exercise 124. (Page 236.)

1.	£1;	£2;	£3;	£4;	£5
2.	5;	10;	15;	20;	25
3.	2;	4;	6;	8;	10
4.	4;	8;	12;	16;	20
5.	3;	6;	9;	12;	15
6.	6;	12;	18;	24;	30
7.	9;	18;	27;	36;	45
8.	8;	16;	24;	32;	40
9.	10;	20;	30;	40;	50
10.	7;	14;	21;	28;	35
11.	1;	1, 10*s*.;	2;	2, 10*s*.	
12.	3;	4, 10*s*.;	6;	7, 10*s*.	
13.	5;	7, 10*s*.;	10;	12, 10*s*.	
14.	7;	10, 10*s*.;	14;	17, 10*s*.	
15.	9;	13, 10*s*.;	18;	22, 10*s*.	
16.	11;	16, 10*s*.;	22;	27, 10*s*.	
17.	13;	19, 10*s*.;	26;	32, 10*s*.	
18.	15;	22, 10*s*.;	30;	37, 10*s*.	
19.	17;	25, 10*s*.;	34;	42, 10*s*.	
20.	19;	28, 10*s*.;	38;	47, 10*s*.	

Exercise 125. (Page 237.)

	s.	*d.*	*s.*	*d.*		£	*s.*	*d.*	£	*s.*	*d.*
1.	2	3;	2	9	16.	0	18	9;	0	19	3
2.	3	6;	3	9	17.	0	19	6;	1	0	6
3.	4	9;	5	0	18.	1	0	9;	1	1	9
4.	5	3;	6	3	19.	1	1	3;	1	2	3
5.	6	6;	7	6	20.	1	2	9;	1	3	6
6.	7	9;	8	9	21.	1	6	0;	1	6	9
7.	8	3;	9	3	22.	1	7	6;	1	7	9
8.	9	6;	10	6	23.	1	8	3;	1	9	3
9.	10	9;	11	3	24.	1	9	9;	1	10	9
10.	11	9;	12	9	25.	1	11	6;	1	12	3
11.	13	6;	13	9	26.	1	12	9;	1	13	9
12.	14	3;	15	3	27.	1	13	3;	1	14	3
13.	15	6;	16	6	28.	1	14	9;	1	15	9
14.	16	9;	17	3	29.	1	15	6;	1	16	9
15.	17	6;	18	6	30.	1	17	3;	1	19	9

Exercise 126. (Page 237.)

1.			2.			3.			4.			5.		
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
0	15	6	0	17	0	0	18	6	1	1	6	1	2	6
1	3	3	1	5	6	1	7	9	1	12	3	1	13	9
1	11	0	1	14	0	1	17	0	2	3	0	2	5	0
1	18	9	2	2	6	2	6	3	2	13	9	2	16	3
2	6	6	2	11	0	2	15	6	3	4	6	3	7	6

6.			7.			8.			9.			10.		
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
0	12	6	0	14	6	0	16	6	0	19	0	1	1	0
0	18	9	1	1	9	1	4	9	1	8	6	1	11	6
1	5	0	1	9	0	1	13	0	1	18	0	2	2	0
1	11	3	1	16	3	2	1	3	2	7	6	2	12	6
1	17	6	2	3	6	2	9	6	2	17	0	3	3	0

11.			12.			13.			14.			15.		
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
1	0	6	1	3	0	1	3	6	0	11	0	0	11	6
1	10	9	1	14	6	1	15	3	0	16	6	0	17	3
2	1	0	2	6	0	2	7	0	1	2	0	1	3	0
2	11	3	2	17	6	2	18	9	1	7	6	1	8	9
3	1	6	3	9	0	3	10	6	1	13	0	1	14	6

16.			17.			18.			19.			20.		
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
1	5	0	1	8	6	1	13	0	1	17	0	2	1	0
1	17	6	2	2	9	2	9	6	2	15	6	3	1	6
2	10	0	2	17	0	3	6	0	3	14	0	4	2	0
3	2	6	3	11	3	4	2	6	4	12	6	5	2	6
3	15	0	4	5	6	4	19	0	5	11	0	6	3	0

Exercise 127. (Page 238.)

	£	s.		£	s.		£	s.		£	s.		£	s.
1.	5	0	7.	19	0	13.	5	15	19.	6	5	25.	22	5
2.	7	0	8.	20	0	14.	7	10	20.	12	15	26.	32	10
3.	9	0	9.	28	0	15.	11	15	21.	14	10	27.	42	15
4.	11	0	10.	42	0	16.	8	15	22.	16	15	28.	55	10
5.	13	0	11.	2	5	17.	9	10	23.	19	10	29.	70	15
6.	*15*	0	12.	3	10	18.	10	15	24.	20	15	30.	81	10

Exercise 128. (Page 238.)

1. 10*d.*
2. 8*d.*
3. 6*d.*
4. 4*d.*
5. 1*s.* 0¼*d.*
6. 1*s.* 1¼*d.*
7. 1*s.* 2½*d.*
8. 1*s.* 3½*d.*
9. 1*s.* 6¾*d.*
10. 9¾*d.*
11. 1*s.* 5¼*d.*
12. 1*s.* 7½*d.*
13. 1*s.* 9¾*d.*
14. 2*s.* 9½*d.*
15. 3*s.* 1¾*d.*

Exercise 129. (Page 239.)

	£	*s.*		£	*s.*		£	*s.*		£	*s.*		£	*s.*
1.	2	8	7.	6	0	13.	2	14	19.	5	5	25.	7	1
2.	3	0	8.	6	12	14.	3	3	20.	6	9	26.	3	15
3.	3	12	9.	7	4	15.	3	18	21.	2	5	27.	5	14
4.	4	4	10.	7	16	16.	1	13	22.	3	9	28.	6	3
5.	4	16	11.	1	10	17.	2	17	23.	4	13	29.	6	18
6.	5	8	12.	1	19	18.	4	1	24.	5	17	30.	7	13

Exercise 130. (Page 239.)

	£	*s.*	*d.*		£	*s.*	*d.*		£	*s.*	*d.*		£	*s.*	*d.*
1.	4	3	4	11.	175	0	0	21.	58	6	8	31.	450	0	0
2.	12	10	0	12.	200	0	0	22.	66	13	4	32.	475	0	0
3.	25	0	0	13.	225	0	0	23.	70	16	8	33.	500	0	0
4.	37	10	0	14.	250	0	0	24.	79	3	4	34.	525	0	0
5.	50	0	0	15.	275	0	0	25.	83	6	8	35.	550	0	0
6.	62	10	0	16.	300	0	0	26.	91	13	4	36.	625	0	0
7.	75	0	0	17.	325	0	0	27.	104	3	4	37.	700	0	0
8.	100	0	0	18.	350	0	0	28.	129	3	4	38.	775	0	0
9.	125	0	0	19.	375	0	0	29.	162	10	0	39.	800	0	0
10.	150	0	0	20.	400	0	0	30.	425	0	0	40.	850	0	0

Exercise 131. (Page 240.)

	£	*s.*	*d.*		£	*s.*	*d.*		£	*s.*	*d.*
1.	1	6	3	2.	1	12	6	3.	1	18	9
	3	18	9		4	17	6		5	16	3
	5	5	0		6	10	0		7	15	0
	6	11	3		8	2	6		9	13	9
	1	19	4½		2	8	9		2	18	1½
	5	18	1½		7	6	3		8	14	4½
	8	10	7½		10	11	3		12	11	10½
	17	14	4½		21	18	9		26	3	1½

	£	s.	d.		£	s.	d.		£	s.	d.
4.	2	6	3	5.	2	12	6	6.	2	18	9
	6	18	9		7	17	6		8	16	3
	9	5	0		10	10	0		11	15	0
	11	11	3		13	2	6		14	13	9
	3	9	4½		3	18	9		4	8	1½
	10	8	1½		11	16	3		13	4	4½
	15	0	7½		17	1	3		19	1	10½
	31	4	4½		35	8	9		39	13	1½
7.	3	17	6	8.	4	12	6	9.	4	18	9
	11	12	6		13	17	6		14	16	3
	15	10	0		18	10	0		19	15	0
	19	7	6		23	2	6		24	13	9
	5	16	3		6	18	9		7	8	1½
	17	8	9		20	16	3		22	4	4½
	25	3	9		30	1	3		32	1	10½
	52	6	3		62	8	9		66	13	1½
10.	5	16	3	11.	6	13	9	12.	6	17	6
	17	8	9		20	1	3		20	12	6
	23	5	0		26	15	0		27	10	0
	29	1	3		33	8	9		34	7	6
	8	14	4½		10	0	7½		10	6	3
	26	3	1½		30	1	10½		30	18	9
	37	15	7½		43	9	4½		44	13	9
	78	9	4½		90	5	7½		92	16	3
13.	7	11	3	14.	7	18	9	15.	8	12	6
	22	13	9		23	16	3		25	17	6
	30	5	0		31	15	0		34	10	0
	37	16	3		39	13	9		43	2	6
	11	6	10½		11	18	1½		12	18	9
	34	0	7½		35	14	4½		38	16	3
	49	3	1½		51	11	10½		56	1	3
	102	1	10½		107	3	1½		116	8	9
16.	8	18	9	17.	9	12	6	18.	10	6	3
	26	16	3		28	17	6		30	18	9
	35	15	0		38	10	0		41	5	0
	44	13	9		48	2	6		51	11	3
	13	8	1½		14	8	9		15	9	4
	40	4	4½		43	6	3		46	8	1
	58	1	10½		62	11	3		67	0	7
	120	13	1½		129	18	9		139	4	[illegible]

	£	s.	d.		£	s.	d.
19.	11	18	9	20.	12	18	9
	35	16	3		38	16	3
	47	15	0		51	15	0
	59	13	9		64	13	9
	17	18	1½		19	8	1½
	53	14	4½		58	4	4½
	77	11	10½		84	1	10½
	161	3	1½		174	13	1½

Exercise 132. (Page 241.)

	£	s.	d.		£	s.	d.		£	s.	d.
1.	1	12	6	2.	2	18	9	3.	3	11	3
	3	5	0		5	17	6		7	2	6
	4	17	6		8	16	3		10	13	9
	8	2	6		14	13	9		17	16	3
	4	1	3		7	6	10½		8	18	1½
	20	6	3		36	14	4½		44	10	7½

	£	s.	d.		£	s.	d.		£	s.	d.
4.	4	11	3	5.	5	18	9	6.	6	12	6
	9	2	6		11	17	6		13	5	0
	13	13	9		17	16	3		19	17	6
	22	16	3		29	13	9		33	2	6
	11	8	1½		14	16	10½		16	11	3
	57	0	7½		74	4	4½		82	16	3

£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.
7	17	6	8.	8	17	6	9.	9	13	9	10.	10	13	9
15	15	0		17	15	0		19	7	6		21	7	6
23	12	6		26	12	6		29	1	3		32	1	3
39	7	6		44	7	6		48	8	9		53	8	9
19	13	9		22	3	9		24	4	4½		26	14	4½
98	18	9		110	18	9		121	1	10½		133	11	10½

Exercise 133. (Page 241.)

£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.
257	1	8	514	3	4	6.	488	10	10	977	1	8
720	0	0	1440	0	0	7.	1643	19	2	3287	18	4
951	9	2	1902	18	4	8.	1856	13	4	3713	6	8
1182	18	4	2365	16	8	9.	1900	12	6	3801	5	0
1414	7	6	2828	15	0	10.	1826	0	10	3652	1	8

Exercise 134. (Page 242.)

	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*
1.	3	18	3	6	10	5	9	2	7	11	14	9
2.	2	12	2	5	4	4	7	16	6	10	8	8
3.	14	6	11	16	19	1	19	11	3	22	3	5
4.	13	0	10	15	13	0	18	5	2	20	17	4
5.	3	5	2½	4	11	3½	5	17	4½	7	3	5½
6.	8	3	0¼	9	9	1¼	10	15	2¼	12	1	3¼
7.	14	0	4¾	15	6	5¾	16	12	6¾	17	18	7¾
8.	3	11	8¾	4	17	9¾	6	3	10¾	7	9	11¾
9.	8	16	0¾	10	2	1¾	11	8	2¾	12	14	3¾
10.	18	18	2½	21	10	4½	24	2	6½	26	14	8½

Exercise 135. (Page 242.)

	£	*s.*	*d.*		£	*s.*	*d.*		£	*s.*	*d.*
1.	50	13	4	5.	183	2	6	9.	22	15	0
2.	101	3	4	6.	37	6	8	10.	32	5	0
3.	11	6	8	7.	33	8	9	11.	97	5	0
4.	22	1	8	8.	162	10	0	12.	15	0	0

Exercise 136. (Page 243.)

	£	*s.*	*d.*		£	*s.*	*d.*		£	*s.*	*d.*
1.	21	6	8	5.	31	17	0	9.	225	6	8
2.	107	13	4	6.	45	3	0	10.	45	18	8
3.	23	16	0	7.	136	3	0	11.	380	18	0
4.	212	9	0	8.	46	7	4	12.	76	10	8

Exercise 137. (Page 243.)

	True.			Banker's.				True.			Banker's.		
	£	*s.*	*d.*	£	*s.*	*d.*		£	*s.*	*d.*	£	*s.*	*d.*
1.	20	0	0	20	10	0	11.	50	0	0	52	10	0
2.	80	0	0	82	0	0	12.	65	0	0	68	5	0
3.	116	13	4	120	3	4	13.	80	0	0	84	8	0
4.	125	0	0	128	15	0	14.	62	10	0	65	18	9
5.	121	13	4	125	18	6	15.	83	6	8	88	6	8
6.	135	16	8	140	11	9	16.	70	0	0	74	4	0
7.	125	0	0	130	0	0	17.	10	0	0	10	12	6
8.	137	10	0	143	0	0	18.	40	0	0	42	10	0
9.	144	0	0	150	0	0	19.	42	18	4	45	18	5
10.	151	4	0	157	10	0	20.	61	13	4	65	19	8

Exercise 138. (Page 244.)

1. 5 % gain.
2. 4 % „
3. $8\frac{1}{3}$ % „
4. $2\frac{1}{2}$ % loss.
5. 2 % „
6. $6\frac{2}{3}$ % „
7. 10 % gain.
8. 5 % „
9. 2 % gain.
10. $8\frac{1}{3}$ % „
11. $6\frac{1}{4}$ % „
12. $2\frac{1}{2}$ % „
13. $9\frac{22}{205}$ % loss.
14. 11 % „
15. 23 % „
16. 5 % „
17. 4 % loss.
18. $8\frac{1}{3}$ % „
19. 10 % gain.
20. 2 % „
21. 4 % „
22. $12\frac{1}{2}$ % „
23. $7\frac{1}{2}$ % „
24. $3\frac{1}{3}$ % „

Exercise 139. (Page 245.)

(In these answers no fractions of a penny are counted.)

	£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.
1.	15	0	0	2.	12	0	0	3.	9	0	0	4.	4	10	0
	30	0	0		24	0	0		18	0	0		9	0	0
	35	0	0		28	0	0		21	0	0		10	10	0
	40	0	0		32	0	0		24	0	0		12	0	0
	45	0	0		36	0	0		27	0	0		13	10	0
	55	0	0		44	0	0		33	0	0		16	10	0

	£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.
5.	13	10	0	6.	10	16	0	7.	7	6	4	8.	9	19	9
	27	0	0		21	12	0		14	12	9		19	19	7
	31	10	0		25	4	0		17	1	7		23	6	2
	36	0	0		28	16	0		19	10	4		26	12	9
	40	10	0		32	8	0		21	19	2		29	19	4
	49	10	0		39	12	0		26	16	9		36	12	7

	£	s.	d.		£	s.	d.
9.	16	4	7	10.	21	16	9
	32	9	2		43	13	7
	37	17	4		50	19	2
	43	5	7		58	4	9
	48	13	9		65	10	4
	59	10	2		80	1	7

Exercise 140. (Page 246.)

1.	£25;	£50;	£100;	£200;	£400
2.	37, 10*s.*;	75;	150;	300;	600
3.	62, 10*s.*;	125;	250;	500;	1000
4.	75;	150;	300;	600;	1200
5.	87, 10*s.*;	175;	350;	700;	1400
6.	31, 5*s.*;	62, 10*s.*;	125;	250;	500

7.	£43, 15*s*.;	£87, 10*s*.;	£175;	£350;	£700
8.	56, 5*s*.;	112, 10*s*.;	225;	450;	900
9.	68, 15*s*.;	137, 10*s*.;	275;	550;	1100
10.	82, 10*s*.;	165;	330;	660;	1320

Exercise 141. (Page 246.)

1.	£10;	£20;	£40;	£80	6.	£35;	£70;	£140;	£280
2.	15;	30;	60;	120	7.	40;	80;	160;	320
3.	20;	40;	80;	160	8.	50;	100;	200;	400
4.	25;	50;	100;	200	9.	60;	120;	240;	480
5.	30;	60;	120;	240	10.	70;	140;	280;	560

Exercise 142. (Page 247.)

1.	£40;	£80	6.	£70;	£140
2.	60;	120	7.	90;	180
3.	80;	160	8.	110;	220
4.	100;	200	9.	130;	260
5.	120;	240	10.	150;	300

Exercise 143. (Page 247.)

1.	£20;	£40;	£80;	£160	6.	£15;	£30;	£60;	£120
2.	30;	60;	120;	240	7.	25;	50;	100;	200
3.	50;	100;	200;	400	8.	35;	70;	140;	280
4.	60;	120;	240;	480	9.	45;	90;	180;	360
5.	40;	80;	160;	320	10.	55;	110;	220;	440

Exercise 144. (Page 248.)

1.	£100;	£50	6.	£20;	£10
2.	180;	90	7.	60;	30
3.	300;	150	8.	80;	40
4.	320;	160	9.	240;	120
5.	500;	250	10.	400;	200

	£	*s*.	*d*.	£	*s*.	*d*.		£	*s*.	*d*.	£	*s*.	*d*.
11.	13	6	8	6	13	4	21.	6	13	4	3	6	8
12.	33	6	8	16	13	4	22.	6	0	0	3	0	0
13.	53	6	8	26	13	4	23.	4	0	0	2	0	0
14.	73	6	8	36	13	4	24.	3	6	8	1	13	4
15.	93	6	8	46	13	4	25.	2	13	4	1	6	8
16.	113	6	8	56	13	4	26.	6	6	8	3	3	4
17.	133	6	8	66	13	4	27.	5	13	4	2	16	8
18.	146	13	4	73	6	8	28.	5	0	0	2	10	0
19.	153	6	8	76	13	4	29.	4	6	8	2	3	4
20.	166	13	4	83	6	8	30.	3	13	4	1	16	8

ISCELLANEOUS QUESTIONS AND EXAMINATION PAPERS.

I. Miscellaneous Questions. (Page 249.)

501018

miles.

375

96, 1*s*. $9\frac{3}{4}d$.

, 0*s*. $4\frac{11}{36}d$.

$\frac{1}{5}$ lbs.

7, 19*s*. $4\frac{1}{2}d$.

yds. 2 ft. 3 in.

5

yds. 2 ft. 4 in.

6*s*. $9\frac{1}{2}d$.

, 10*s*.

5 seconds from start.

41

8, 8*s*. $9\frac{1}{4}d$.

wts. $8\frac{19}{40}$ grs.

$3\frac{1}{4}d$.; $\frac{7}{15}$

1*s*. 0*d*. per cwt.

s. 4 oz. 1 dwt. 14·4 grs.

copper, 7 oz. 18 dwts.

6 grains of zinc.

yards.

, 4*s*. 6*d*.

, 2*s*. $6\frac{3}{4}d$.

, 8*s*. $11\frac{1}{4}d$.

°/o

1*s*. 3*d*. or 5 °/o loss.

st son = $\frac{11}{18}$, second = $\frac{7}{18}$.

q. ft.

, 15*s*. 7*d*.

,000

a quart.

ours.

35. £35
36. £6, 6*s*.
37. $\frac{7}{8}$; ·14625
38. $1\frac{1}{90}$; 8·8
39. 3 tons 4 cwts. 3 qrs. 4 lbs. 13 ozs.
40. 171
41. £98, 2*s*. $4\frac{1}{2}d$.
42. 162 bushels.
43. A's share = £212, 2*s*., B's = £353, 10*s*., C's = £388, 17*s*.
44. 10 °/o
45. 1*s*. $0\frac{3}{4}d$.
46. £4, 19*s*. $1\frac{1}{2}d$.
47. £485, 1*s*. 9*d*.
48. 144
49. £781, 1*s*. 8*d*.; £2343, 5*s*.
50. £1869
51. £3, 10*s*.
52. Compound interest = 11*s*. $6\frac{2862}{3125}d$. above simple interest.
53. 3738
54. 864; £233, 17*s*. 9*d*.
55. £3, 6*s*. per qr.
56. Compound interest = 1*s*. $7\frac{43}{200}d$. more than simple.
57. £10, 11*s*. 6*d*.
58. 10*s*.
59. Compound interest = 1*s*. $0\frac{2196}{15625}d$. in excess.
60. 4*s*. $4\frac{1}{2}d$.
61. 8000; ·00125; $\cdot\dot{3}7\dot{5}$
62. £4802, 15*s*. $3\frac{3}{4}d$.
63. 62 children; $83\frac{1}{3}$ cub. ft.
64. 1 cwt. 3 lbs.

65. 591360
66. Both = 7*s.* 6*d.*
67. $11\frac{1}{17}$ dwts.
68. $33\frac{1}{3}$ °/ₒ
69. £2418, 6*s.* 8*d.*
70. $55\frac{5}{9}$ sq. ft.; 18*s.* $6\frac{2}{9}$*d.*
71. £9, £15, and £21
72. 480 feet.
73. 4 °/ₒ
74. £2, 8*s.* $6\frac{68}{105}$*d.*
75. 13 times.
76. $24\frac{2}{3}$ loss per cent.
77. 3·875; 14·53125; 3·75
78. 3 ozs. 8 drs.
79. Three thousand eight hundred and seventy-four.
80. £107, 9*s.* $9\frac{11}{21}$*d.*
81. 1 pint $= \frac{277}{8 \times 1728} \times 1000$ ozs. $= 20\frac{65}{1728}$ ozs. $= 1\frac{1}{4}$ lb. + $\frac{65}{1728}$ oz.
82. The latter by $1\frac{59}{85}$*d.*
83. £80
84. A = £53, 11*s.* $0\frac{1836}{2857}$*d.*; B = £53, 6*s.* $0\frac{456}{2857}$*d.*; C = £73, 2*s.* $11\frac{565}{2857}$*d.*
85. £631, 10*s.*
86. £879, 14*s.* $8\frac{1}{4}$*d.*
87. £3, 10*s.*
88. 1*s.* 3*d.*
89. £2, 10*s.* @ 1*s.* per 9 *square* yards.
90. A to B to C as 28 to 35 to 36.
91. $\frac{\text{Number of posts} \times 60 \times 60}{1760} = 2\frac{1}{22} \times$ number of posts = twice roughly.
92. 28 miles.
93. Four billion, two hundred and sixty-one thousand million, eight hundred and seven thousand and six.
94. £160
95. £40, 15*s.* $7\frac{1}{2}$*d.*
96. 9820
97. 11 ft. $3\frac{3}{4}$ in. (correct to $\frac{1}{33}$ inch).
98. 17*s.* 6*d.*
99. $19\frac{13}{23}$ yards.
100. 307 yrs. 307 dys. 20 hrs. $43\frac{11}{23}$ min. (1 year = $365\frac{1}{4}$ days).
101. 2*s.* 3*d.*
102. 6*s.* 3*d.*; ·018125
103. 4*s.* $9\frac{3}{4}$*d.*; £252; £120; £36
104. ·82135.
105. The wine in B is equal to the water in C, viz. $1\frac{1}{4}$ gallons.
106. 14·3
107. In 9 hours, *i.e.* at 6 o'clock.
108. A must pay B 2*s.* 6*d.* and C must pay B 3*s.*
109. £37, 16*s.* $4\frac{1}{2}$*d.*
110. 18 feet.
111. 5081; 16·066
112. $22\frac{2}{3}$
113. $\frac{9}{56}$
114. $\cdot000\dot{5}3\dot{5}$; $\frac{107}{199800}$
115. 908 yards.
116. From £124 to £100 a year.
117. £150 loss.
118. $\frac{1}{6}$
119. $67\frac{7}{8}$
120. $\frac{1}{6}$
121. 7048
122. ·43
123. $1\frac{5}{42}$
124. ·00102
125. 17*s.* 6*d.*; ·125
126. $1\frac{1}{15}$
127. 2*s.* 6*d.*
128. 317450
129. 16 times in each case.
130. £33, 15*s.*

131. $\frac{11}{210}$
132. $\frac{1}{250000}$ inch.
133. 7 per cent loss.
134. £4, 17*s*. 6*d*.
135. 34 sq. ft. 108 in.
136. $4\frac{1}{2}$*d*.
137. £50
138. 3 ro. 10 po.
139. 759
140. $\cdot 32\dot{7}$

141. $4\frac{151}{216}$
142. £8, 18*s*. 9*d*.
143. £3000
144. 2*s*. $2\frac{1}{2}$*d*.
145. 352 times.
146. £3, 14*s*. 3*d*.
147. 1 ton 3 cwts. 1 qr. $\frac{1}{6}$ lb.
148. $\frac{11}{12}$
149. 11*s*. $1\frac{1}{2}$*d*.; ·11125
150. ·00501

151. 10*s*.
152. £21, 11*s*. $11\frac{197}{800}$*d*.
153. £976, 12*s*. 6*d*.
154. ·007252; ·98
155. 1
156. £1
157. ·1390625
158. Each = £10, 10*s*.
159. $\frac{43}{102}$; 25
160. 2 fur. $14\frac{124}{175}$ po.

161. 3 sq. yds. 29 in. very nearly.
162. £7, 4*s*. $11\frac{2}{5}$*d*.
163. 88 per cent passed.
164. $8\frac{1}{3}$ yards.
165. £60, 0*s*. 6*d*.
166. 8 hours.
167. $\frac{1}{5}$
168. 12·03
169. 14*s*. $5\frac{1}{3}$*d*.; ·14
170. 1 lb. 4·057 oz.

171. 4·3588
172. £963, 19*s*. $10\frac{254}{287}$*d*.
173. The 10 T. and 12 C. = £1, 16*s*. more than the 15 T.
174. 12 miles.
175. 17*s*. $6\frac{1}{2}$*d*.; $\cdot 017541\dot{6}$
176. 25 %
177. $1\frac{17}{88}$; $8\frac{16}{21}$
178. £650
179. £646, 10*s*. $4\frac{1}{2}$*d*.
180. 29167; 13739; 3686; 3408

181. 11
182. £19, 19*s*. $3\frac{1}{2}$*d*.
183. $\frac{7}{8}$; $\frac{11}{12}$; 1
184. $3\frac{7}{108}$
185. $\cdot\dot{0}5$
186. £20
187. Loses 25 francs, or £1
188. £9, 13*s*. $8\frac{20}{41}$*d*.
189. £2, 10*s*.
190. £2103, 14*s*. 1*d*.

191. $1\frac{7}{81}$
192. 24855 miles 2 fur. 14 po. 5 yds. 8 in.
193. $\frac{3}{160}$; $\frac{1}{4}$; $\frac{1}{8}$
194. 3·25; 3250
195. 28464
196. 64 times.
197. $\frac{47}{48}$
198. A = £2, 19*s*. 7*d*.; B = £11, 18*s*. 4*d*.; C = £10, 14*s*. 6*d*.
199. $\frac{5}{9}$; $\frac{13}{48}$; $\cdot 2847\dot{2}$
200. 83 ft. 5 in.

II. Intermediate Arithmetic. (Page 262.)

1. 7 ft.
2. $51\frac{1}{3}$ oz.
3. $3\frac{1}{2}$
4. $2\frac{1}{4}$ years.

5. £17, 3*s*. 9*d*.
6. 105 days.
7. £211, 9*s*. 8*d*.
8. 72 yards.
9. £640
10. £189, 3*s*.
11. 2
12. 4 °/ₒ
13. 2 at 2*s*. 3*d*., 13 at 13*s*. 6*d*.
14. £945, 3*s*. 4*d*.
15. 14*s*.
16. 5508
17. 17 cwts. 1 qr. 12$\frac{1}{2}$ lbs.
18. 17*s*.; 13*s*.; 10*s*.
19. 12 days.
20. ·2; ·7
21. $\frac{25}{32}$
22. 2$\frac{2}{5}$ days.
23. £34503, 9*s*. 4$\frac{1}{3}$*d*.
24. £5, 4*s*. 0$\frac{3}{16}$*d*.
25. £450
26. 18 shillings 15 sixpences.
27. £825; £450; 20 °/ₒ
28. £7000
29. $\frac{1}{12}$
30. £55, 15*s*. 7$\frac{1}{2}$*d*.
31. £2666, 13*s*. 4*d*.
32. £5
33. £2, 4*s*. 4$\frac{1}{2}$*d*.
34. 1
35. 1771
36. £507, 17*s*. 0$\frac{3}{4}$*d*.
37. £10033
38. 17*s*. 6*d*.
39. £11, 17*s*. 5*d*.
40. 2$\frac{11}{59}$
41. £4698, 7*s*. 6*d*.
42. 1 day.
43. 36 men.
44. 3$\frac{1}{2}$ °/ₒ
45. 29 francs 40 centimes.
46. 5$\frac{1}{16}$ days.
47. 120
48. 24000
49. 5$\frac{1}{4}$ °/ₒ
50. 7$\frac{43}{60}$
51. 6$\frac{43}{65}$
52. 1$\frac{14}{19}$
53. 1$\frac{9}{11}$
54. ·192951
55. 3·074
56. ·0234
57. $\cdot\dot{1}$
58. £1137, 10*s*.
59. £428
60. 14 cwts. 2 qrs. 18$\frac{2}{3}$ lbs.; 3 cwts. 12$\frac{4}{9}$ lbs.; 2 cwts. 24$\frac{8}{9}$ lbs.
61. £118, 2*s*.
62. 60 shillings.
63. 7$\frac{5}{9}$
64. 9009
65. £124, 9*s*. 2*d*.; £93, 6*s*. 10$\frac{1}{2}$*d*.; £74, 13*s*. 6*d*.; £62, 4*s*. 7*d*.
66. £1240
67. £71$\frac{7}{23}$
68. 360360
69. £12
70. 3$\frac{1}{2}$ °/ₒ
71. 12$\frac{1}{2}$ hours per day.
72. Gain £1, 17*s*. 6*d*.
73. 9$\frac{4}{5}$ °/ₒ
74. 10 years.
75. £720
76. 6$\frac{34}{63}$
77. £588, 11*s*. 11*d*.
78. £3, 2*s*. 0$\frac{2}{3}$*d*.
79. 4 horses.
80. £100
81. £7, 7*s*. 7*d*.
82. 1
83. 121; 13728
84. £1, 0*s*. 8$\frac{35}{36}$*d*.
85. 1$\frac{9}{20}$; 10$\frac{11}{70}$

86. 66 days.
87. 10*s.*
88. Loses £5
89. 7402 and 67 remainder.
90. 5 months.
91. £723, 5*s.* 4$\frac{1}{2}$*d.*
92. £650
93. 399; 65520
94. 66
95. 14$\frac{2}{17}$ minutes.
96. 2260; $\frac{1}{7}$; 1
97. 6
98. £76, 14*s.* 7*d.*
99. £165, 12*s.*
100. £117
101. 1
102. A, £106$\frac{65}{67}$; B, £79$\frac{32}{67}$; C, £169$\frac{37}{67}$
103. 23 tons 18 cwts. 2 qrs. 8 lbs.
104. 84870834—3575
105. £2064, 9*s.* 3*d.*; £171, 10*s.* 2$\frac{1}{4}$*d.*
106. 1$\frac{83}{100}$; 3$\frac{25}{31}$
107. 9$\frac{2427}{5670}$
108. 3780; $\frac{547}{741}$
109. $\frac{2}{3}$
110. 1618·64
111. £75, 6*s.* 3*d.*; £225, 18*s.* 9*d.*; £376, 11*s.* 3*d.*; £527, 3*s.* 9*d.*
112. 11
113. 25·886375; 1015·1519 +
114. £383, 16*s.* 11*d.*
115. 7
116. £2732, 5*s.* 10*d.*
117. 63
118. 22440
119. 3$\frac{43}{50}$
120. 26$\frac{7}{40}$; 36$\frac{1087}{1210}$
121. 1$\frac{2}{3}$ × 2$\frac{5}{8}$ is greater by 3·9862
122. 2$\frac{2}{21}$
123. $\frac{11}{60}$
124. ·35665; 29219·84
125. £553, 11*s.* 6*d.*
126. £27, 10*s.* 11$\frac{1}{2}$*d.*
127. 217
128. 60
129. £140
130. 3$\frac{1}{210}$
131. 10 years.
132. £160
133. A 1900, B 1500, and C 1200; A £142, 10*s.*, B £112, 10*s.*, C £90
134. £42, 15*s.* 10*d.*
135. 28 days.
136. £352, 5*s.* 8$\frac{3}{4}$*d.*; £203, 18*s.* 7*d.*
137. £633, 16*s.* 6*d.*
138. 1$\frac{191}{625}$; 11$\frac{47}{560}$
139. £3, 3*s.* 3$\frac{3}{4}$*d.*
140. 8 lbs.
141. 2 miles 7 fur. 1 yd. 1 ft. 6 in.; 1323.
142. 10$\frac{1}{7}$; 1
143. 12 hours.
144. 7$\frac{3}{7}$ months.
145. 10*s.* 8$\frac{38}{125}$*d.*; 1 qr. 23 lbs. 4 oz. 11$\frac{97}{125}$ drs.; 7 fur. 31 po. 1 yd. 2 ft. 6 in.
146. £1202, 10*s.*; £39
147. 2481
148. £9222, 18*s.* 7$\frac{1}{2}$*d.*
149. 1274·49
150. $\frac{3}{5}$
151. £6, 12*s.* 5$\frac{5}{8}$; ·5
152. 4$\frac{1}{2}$ %
153. 4$\frac{1}{6}$ %
154. £90
155. $2\cdot\dot{3}$
156. 9 months.
157. 2*s.* 8*d.*

158. 14 lbs. 6 oz. 13 dwts. 18 grains.
159. $4\frac{1}{2}$ years.
160. £12, 17*s.* 3*d.*; ·125
161. 7*s.* 6*d.*
162. $1\frac{31}{120}$; $\frac{11}{151}$; $\frac{50}{343}$
163. A $4\frac{2}{3}$ miles, B $5\frac{1}{3}$ miles.
164. 24·16; $3{\cdot}08\dot{5}\dot{4}$; $11{\cdot}8\dot{9}\dot{4}$
165. 28·163862 kilometres.
166. 180,000 tons.
167. £3, 17*s.* $10\frac{4}{5}$*d.*
168. 3 °/ₒ
169. £5003, 5*s.* $1\frac{1}{4}$*d.*
170. £93, 17*s.* $3\frac{87}{119}$*d.*
171. 1616160
172. $2\frac{137}{3200}$; $3\frac{209}{3000}$; $3{\cdot}069\dot{6}$
173. ·0025
174. 3·28
175. £7, 10*s.* 8*d.*
176. 6480 francs 51 centimes.
177. $5\frac{61}{288}$; $8\frac{153}{160}$
178. £102, 18*s.* 4*d.*
179. £663, 6*s.* 9*d.*
180. 282; 288
181. £6, 3*s.* 3*d.*; 20 °/ₒ
182. 7·75 cwts.
183. 24 years.
184. $5\frac{1}{2}$ °/ₒ
185. £413, 4*s.* $4\frac{4}{23}$*d.*; £367, 6*s.* $1\frac{1}{23}$; £275, 9*s.* $6\frac{18}{23}$*d.*
186. £103, 10*s.*; £102
187. 141036
188. 3 fur. 37 po. 4 yds. 1 ft. 6 in.
189. $2\frac{1}{210}$
190. 33 men.
191. $\cdot2598\dot{7}32\dot{6}$
192. A 6*s.* 4*d.*, B. 8*s.* 2*d.*, C 5*s.* 2*d.*
193. $28\frac{1}{8}$
194. £1, 17*s.* $11\frac{4171}{7300}$; £418, 0*s.* $5\frac{4171}{7300}$*d.*
195. £15; 12 °/ₒ
196. 2, 2, 2, 3, 3, 7, 11, 17;
2, 2, 2, 3, 3, 7, 11, 19;
G.C.M. or H.C.F. = 5544;
L.C.M. = 1790712; $\frac{17}{19}$
197. 1 shilling.
198. ·05
199. £3600
200. $12\frac{1}{8}$
201. 1·3165; ·1732
202. $\cdot708\dot{3}$; $\cdot6791\dot{6}$; $\cdot119791\dot{6}$; £1, 10*s.* $1\frac{3}{4}$*d.*
203. £3750
204. ·068; $\cdot\dot{2}57142\dot{8}$
205. ·0140184
206. £492, 4*s.* $10\frac{1}{2}$*d.*
207. $4\frac{3}{4}$
208. 2 po. 16 yds. 5 ft. 136 in.
209. 100 lbs.
210. $2\frac{53}{100}$; $\cdot10\dot{1}8\dot{5}$
211. £9, 7*s.* 6*d.*
212. $\cdot0069\dot{4}$; ·23046
213. 3·590625; 8*s.* 6·2*d.*
214. $7\frac{33}{80}$; £1, 1*s.*
215. $366\frac{27}{32}$
216. $\frac{35}{44}$; 34; 420
217. $\frac{17}{400}$
218. £7350 stock; £251, 17*s.* $9\frac{3}{4}$*d.*
219. $2\frac{3}{4}$
220. ·28
221. Sum $1\frac{3071}{24975}$; difference $\frac{11396}{24975}$; product $\frac{19721}{74925}$; quotient $2\frac{3071}{8325}$
222. 4 oz. 13 dwts. $17\frac{127}{385}$ grs.
223. C first, B 1 ft. behind, A 2 ft. behind.
224. 20 men.
225. £137, 10*s.*

226. 4652; ·4652; 35·5681
227. $\cdot 6\dot{3}2\dot{8}$; $\cdot 826\dot{2}1\dot{3}$
228. £2, 1*s*. 8*d*.
229. £18, 18*s*.
230. 538·8; ·5388; 2·2503
231. $\cdot 5\dot{2}7\dot{6}$; $\cdot 12\dot{3}65\dot{7}$
232. 3·5615 +
233. See Key.
234. £275
235. 3, 3, 7, 11, 17, 13; 238901
236. 3·1104
237. 1
238. 4*s*. 3$\frac{72}{77}$*d*.
239. 11*s*. 4$\frac{2}{7}$*d*.
240. 2$\frac{30}{83}$
241. 7, 11, 13, 19, 13; 3220525308
242. 4$\frac{4}{9}$
243. 421
244. 1 quart.
245. £31, 10*s*.
246. 20 days.
247. 1
248. 2560
249. £6, 0*s*. 6*d*.; 10*s*. 4*d*.
250. £240
251. 25
252. $\frac{7}{15}$; 17·2
253. 147
254. 15 days.
255. 2 miles an hour.
256. 3 days.
257. 3
258. ·0098; 64
259. $\cdot 594791\dot{6}$
260. £97, 13*s*.
261. ·3
262. 69 half-sovereigns, 115 half-crowns, 161 sixpences.
263. £320
264. 3$\frac{1}{4}$ %
265. 35 %
266. $\frac{1}{9}$
267. £2566, 13*s*. 4*d*.
268. 37·5025; 15640·625
269. $\cdot 87497\dot{6}$
270. 169 yards by 25
271. 686 francs 87·5 centimes.
272. A in 12$\frac{1}{2}$ days, B in 18$\frac{3}{4}$ days.
273. 3·765; 89·375
274. $\cdot 1891\dot{6}$
275. 709 lire 61·25 centesimi.
276. £7, 8*s*. 9*d*.
277. £37, 7*s*.
278. 5$\frac{4}{7}$ days.
279. $\cdot 35208\dot{3}$
280. £3, 10*s*.
281. 48 half-sovs., 96 half-crowns, and 176 threepences.
282. £18
283. £6, 17*s*. 6*d*.
284. 42444
285. 28 ft. 33$\frac{137}{144}$ ins.
286. $\frac{319}{9375}$
287. 73 cub. yds. 8 cub. ft. 98 cub. in.
288. 275112$\frac{1}{2}$ sq. links.
289. ·000156
290. ·5972
291. 62573$\frac{210}{23}$
292. 15*s*. 6$\frac{3}{4}$*d*.; 3*s*. 9*d*.
293. ·40625
294. £32, 8*s*. 11·52*d*.
295. ·0763; ·3125
296. 1234; 3$\frac{1}{11}$
297. 6·928
298. 7·872
299. 904 tons.
300. 17·9$\frac{549}{9167}$

III. Advanced Arithmetic Questions. (Page 281.)

1. $10\frac{13}{27}$; 10 ft. 7 in.
2. $15\frac{1}{2}$ miles nearly.
3. 25 ft. 11·06 in.
4. £112, 11*s.* 6*d.*
5. 3·37 shillings.
6. 372
7. 131 yds.
8. 1 in 14
9. 40,000 bricks.
10. 125 to 231
11. $3\frac{61}{88}$ °/。
12. 528400 sq. ft.
13. 220 to 171
14. 4 ft.
15. The 4 per cents; £37,800
16. 19 miles 760 yds.
17. £809, 15*s.*
18. 6685 coins.
19. 67035024; one billion, one hundred and ten thousand and eleven million, one hundred thousand, one hundred and eleven; $\frac{8}{9}$
20. 4·3588; 5·91
21. 74; 30898033320
22. $\frac{3773}{4216}$; ·75
23. The 4·4 per cent @ $96\frac{2}{3}$
24. £11, 5*s.* $6\frac{3}{4}$*d.*
25. £46, 6*s.* 11·8*d.*
26. £50350, 12*s.* 6*d.*
27. 98 sq. yds.
28. $11\frac{71}{308}$ sec.
29. $16\frac{24}{43}$ °/。
30. 10111111101; ten thousand one hundred and eleven million, one hundred and eleven thousand, one hundred and one.
31. $38\frac{2}{11}$; $\cdot 0\dot{5}\dot{2}$
32. $\frac{3}{7}$ [£86, 13*s.* $0\frac{3}{32}$*d.*
33. See Text, page 143;
34. $\cdot 380208\dot{3}$
35. 5·5677
36. £1, 9*s.* $7\frac{5}{7}$*d.*
37. $4\frac{5}{8}$ mos.
38. 62·5
39. 142857
40. £6, 9*s.* 10*d.*
41. £580
42. £149, 2*s.* $7\frac{1}{4}$*d.*
43. £3, 18*s.* 9*d.*
44. $1\frac{3}{5}$
45. $\frac{31}{50}$.
46. $61\cdot\dot{1}$
47. 281463—654; $291\cdot\dot{8}\dot{1}$
48. £4, 0*s.* $3\frac{3}{4}$*d.*
49. 18900 links.
50. 3 ft. 4 in.
51. 1369; ·1259
52. 5 ft. 5 in. nearly.
53. £45; £49, 10*s.*; £50
54. $3\frac{1}{2}$ °/。
55. £426, 13*s.* 4*d.*
56. £11, 4*s.* 3·36*d.*
57. 5 hrs. $38\frac{2}{41}$ min.
58. ·4106856
59. 8·175; 5·90625
60. $\cdot 8\dot{3}$
61. £511, 12*s.* 8*d.*
62. £27, 8*s.* $6\frac{2}{3}$*d.*
63. £108
64. 60*s.*
65. 6 weeks.
66. $\frac{1}{4}$ of contents.
67. £7358400
68. 5·477; ·31075; 69·5701 yds.

69. £4000
70. 13317
71. £4, 10*s.*
72. 30 days.
73. 2809 cub. ft. 198 cub. in.
74. 15 yds. 2 ft. 10 in.
75. 40 ac. 2 ro. $1\frac{2}{13}$ per.; 25 ac. 17 per.; 29 ac. 2 ro. $32\frac{11}{13}$ per.
76. £1829, 6*s.* 8*d.*
77. 29120
78. £4970
79. $5\frac{1}{3}$ yds.
80. 7*s.* $10\frac{7}{8}$*d.*
81. H. C. M. 180; L. C. M. 189189000
82. ·113722
83. 2*s.* 8*d.*
84. 1090 c. ft. $1010\frac{25}{48}$ c. in.
85. £1, 12*s.* 6*d.*
86. $26\frac{2}{5}$ hrs.
87. £9, 11*s.* 3*d.*
88. £56, 3*s.* 11*d.*
89. £1, 16*s.*; $4\frac{1}{2}$*d.*
90. 14·215
91. $\frac{29}{98}$ in.; $\frac{9}{14}$ in.; $1\frac{1}{42}$ in.
92. $14\frac{1}{2}$ m. from D; $11\frac{1}{2}$ m. from A; $12.37\frac{1}{2}$ p.m.
93. $1\frac{1}{2}$*d.*
94. $\cdot\dot{0}\dot{9}$
95. £1750
96. 899 c. ft. 206 $\frac{1}{48}$ c. in.
97. £450
98. 750 men.
99. 13 ft. 6 in.
100. 66 apples, 44 pears, 12 plums, 42 cherries, 28 walnuts.
101. £144, 6*s.* 11*d.* gain.
102. $10\frac{9}{23}$; 7·03
103. Distance to Oxford 60 m.; (*b*) coach leaves London 7.30 a.m., arrives at Oxford 1.30 p.m., meets wagon $2.52\frac{1}{2}$ p.m., reaches London 8.30 p.m.; wagon arrives at Oxford 3.30 p.m.
104. $\frac{19}{84240}$
105. 886 remainder.
106. ·06031; $156\frac{131}{238}$
107. 120 c. yds. 18 c. ft. 1296 c. in.; 86 sq. yds. 54 in.
108. B 45, C $65\frac{1}{4}$, D $46\frac{7}{8}$
109. 2·8; difference 9·4582
110. £22666, 13*s.* 4*d.*
111. 11 to 12
112. 7·6890625 °/o
113. £1564
114. £231, 4*s.* 7*d.* gain.
115. Total £4875; A £1625, B £$1083\frac{1}{3}$, and C £$866\frac{2}{3}$; D £780, and E £520.
116. 4 ft. $2\frac{26}{35}$ in.
117. $15\frac{12}{19}$; 91·0036
118. $\cdot 0\dot{1}$
119. 1104 c. ft. $816\frac{31}{48}$ c. in.
120. 127 in.; 74 sq. yds. 6 ft. 6 in.
121. £1200; £875
122. £8500; £65, 12*s.* 6*d.*
123. $126\frac{63}{275}$ grs.
124. A $7\frac{1}{3}$ m.; B $4\frac{1}{2}$ m.
125. 119
126. B 6 secs., C 15 secs.
127. 4633 white, 240 red.
128. $245\frac{5}{8}$ sq. ft.
129. $1\frac{2}{5}$
130. £3, 1*s.* $8\frac{5}{24}$*d.*
131. 77824
132. £3, 1*s.* 1*d.*
133. 729·33; 11 ft. 6 in.
134. £19, 16*s.* 8*d.*
135. £4383, 18*s.* 9*d.*

136. £441
137. 3 hrs. 5 min.
138. $3\frac{1}{2}$ miles and 5 miles per hour respectively.
139. 4 °/o
140. $25\frac{5}{17}$; 11·76
141. $3\frac{179}{407}$
142. 34 c. yds. 21 c. ft. $1255\frac{1}{2}$ c. in.
143. 16·392 ft.
144. £500
145. The 2nd is 330 yds. and the 3rd 1650 yds. from goal.
146. 3·08 ft.
147. 680 ft.
148. A 800, B 500, C 300
149. £4, 18*s.*
150. 544 lines.
151. 18·4325
152. 80 °/o lost.
153. 11 hours.
154. £4, 15*s.* $2\frac{6}{7}$*d.*; £$15\frac{3}{7}\frac{1}{7}\frac{5}{9}$
155. £28, 11*s.* $9\frac{3}{4}$*d.*
156. $1\frac{1}{5}$, or 2 men.
157. 2505·078125
158. $62\frac{1}{2}$
159. For solution of this question see Key.
160. 3 lbs. 7 oz. 8 dwts.
161. $\cdot 99\dot{6}\dot{1}$
162. He answers 52 °/o and passes.
163. £25
164. 83·5505 acres.
165. 192000
166. Suppose P = price of 1 cwt. in shillings then P ÷ 112 = price of 1 lb. in shillings; ∴ P ÷ (112 × 48) = price of 1 lb. in farthings, and dividing both multiplier and divisor by 16 the expression becomes P ÷ 7 × 3.
167. 3522178; 3998936616
168. $\frac{11}{26}$
169. 1100 ft. per second.
170. £1 per share.
171. £10
172. $77\frac{1}{2}$
173. 3
174. B wins by 50 yds. in $4\frac{3}{4}'$.
175. 150 lbs.
176. £12000
177. $25\frac{11}{19}$ francs.
178. $30\frac{5}{64}$ °/o
179. 17609·705
180. 35·38 oz. very nearly.
181. $3\frac{1}{2}$
182. 98
183. $\frac{1}{2}$ hour each day.
184. A's £501, 16*s.* 6*d.*; B's £250, 18*s.* 3*d.*; C's £83, 12*s.* 9*d.*; D's £20, 18*s.* $2\frac{1}{4}$*d.*
185. £2350
186. 2 ac. 2 ro. 36 po. very nearly.
187. £70
188. 4 years.
189. £259, 14*s.* 3*d.*
190. 564
191. $1\frac{1}{39}$ lbs.; $\frac{10}{13}$ lbs.; $\frac{20}{39}$ lbs.
192. 80300000 francs.
193. $\frac{8}{77}$ gall.
194. 9, 5, 1, 6 or 5, 9, 6, 1
195. 98 ac. 1 ro. 6·82 po. very nearly.
196. 19855·6974 sq. inches.
197. 509·208 cub. inches.
198. £2080
199. £31350
200. £2010

201. 50 tons 12 cwts. 3 qrs. 9 lbs. 8 oz.; 32410 tons 14 cwts. 1 qr. 4 lbs.
202. $2\frac{14}{29}$ days.
203. 45 miles.
204. $5\frac{1}{68}$ °/₀
205. 196 yds. 2 ft. 3·8 in.

206. £32, 3*s*. 4*d*.; $1{\cdot}\dot{0}2116\dot{4}$
207. 14*s*. 9·876*d*.
208. £$242914\frac{242}{247}$
209. $6\frac{3}{5}$ days.
210. $1\frac{83}{205}$

211. A's stock is £4000, B's £2500; A's profit is £$1523\frac{1}{13}$, and B's £$951\frac{12}{13}$
212. 192 and 150
213. £1000
214. A's = £200; B's = £120; C's = £225.
215. 702 for defeated candidate, 1458 for winner; gross 2430.

216. £10 = gain on 1st half, £20 gain on 2nd; 6 °/₀
217. 3 ft. 9 in.
218. £37, 10*s*.
219. English most profitable; £4000
220. 15 and 384

221. £1258, 19*s*. $6\frac{3}{10}$*d*.
222. £700 in 3 °/₀; £600 in 5 °/₀; £4 loss.
223. 75
224. $27\frac{3}{31}$
225. $69\frac{3}{8}$

226. 18
227. See Key.
228. See Key.
229. $18\frac{2}{11}$′ past 1.
230. $88\frac{1}{2}$°

231. $2215404\frac{4}{7}$
232. £90, 3*s*. $1\frac{3}{4}$*d*.
233. $5\frac{5}{11}$ min. past 10; $21\frac{9}{11}$′ past 10; $54\frac{6}{11}$′ past 10.
234. 18*s*. $10\frac{1}{3}$*d*.
235. 5*s*. $7\frac{7}{12}$*d*.

236. £$710\frac{15}{16}$ and £$1206\frac{4}{41}$
237. 12420
238. $41\frac{2}{3}$
239. 4 stone; £$3\frac{3}{5}$ per ton.
240. See Key.

241. 4*s*. $6\frac{3}{7}$*d*.
242. $3\frac{372}{503}$ hrs., and A walks $12\frac{120}{503}$ miles, B $14\frac{383}{503}$ miles.
243. 15*d*.
244. 11 ft. $2\frac{1}{5}$ in.
245. £1, 5*s*.

246. On 15th June at $10\frac{10}{17}$′ past 11 a.m.; 56′ $28\frac{4}{17}$″ past 10, and 26′ $28\frac{4}{17}$″ past 11.
247. $58\frac{6}{13}$ °/₀
248. 4*s*.
249. £$270\frac{813}{1070}$
250. $2\frac{2}{3}$ miles per hour.

251. A 15, B 30, C 60 days.
252. 2703360
253. 12 half-crowns, 24 pence, 36 sovereigns, and 96 shillings.
254. A 336, B 420, C 210
255. £1 received in January, £23 in December.

256. 122212111
257. 30·205
258. 10°
259. ·00000362811
260. 4*s*. 2*d*. = tea; 1*s*. 2*d*. = chocolate.

261. $\frac{1}{4}\sqrt{3}$
262. £5, 19*s*. 3*d*.
263. 23 lbs. 3 oz. 12 dwts. 22·46875 grs.

264. $382\frac{1}{2}$ feet.
265. 3 years.
266. 10 months.
267. £$666\frac{2}{3}$
268. 3*s*. and 4*s*.
269. 15
270. 6*d*. for 25 apples; 2*d*. for 5 pears; and 9*d*. for 10 oranges.
271. $\bar{1}\cdot0457574$; $\bar{1}\cdot09691$; $\bar{3}\cdot30103$; $2\cdot3344539$; $0\cdot0334239$; $\bar{1}\cdot3467874$
272. 14·625
273. $1\frac{19}{29}$
274. 15′ and $9\frac{3}{13}$′
275. 8000, 7200, 6750
276. 5 oz. 7 dwts. $3\frac{11}{159}$ grains.
277. £65275 in each; $3\frac{1}{2}$ the better.
278. 14, 12, and 16 days respectively.
279. $57\frac{1}{2}$
280. 16 lbs. of 3*s*. 9*d*. to 3 lbs. of each of the others; 544, 33, 33, and 176 lbs. respectively.
281. 9 days.
282. £5246, 5*s*.
283. As 9 to 5.
284. £18000
285. £42, 17*s*. $4\frac{1}{2}$*d*.
286. 1 acre $22\frac{1}{4}$ perches.
287. £9880
288. 75
289. 25*s*.
290. $2\frac{2}{3}$ months.
291. 3249; 57*s*.
292. $17\frac{17}{59}$
293. 5*s*. and 4*s*.
294. $10\frac{2}{7}$ miles per hour.
295. A gets £7000, B £8500, and C £20,000; capital £20,000.
296. 5 %
297. 1·48
298. 8 ft.
299. A 240, B 360, C 300, D 400.
300. 21 miles.

IV. Matriculation Examination Papers.

(Page 310.)

1877.

1. £$10\frac{55}{127}$
2. £5, 16*s*. $5\frac{1}{2}$*d*.; £2, 17*s*. $6\frac{1}{4}$*d*. + $\frac{1}{4}$
3. $4\frac{7}{11}$ hours.
4. $\frac{1349}{1120}$ or $1\frac{229}{1120}$
5. $\frac{1}{11088}$*s*.
6. ·42; 5·26; ·12

1878.

1. $2\frac{11}{12}$ hours.
2. £1014, 18*s*.; £6, 14*s*. $4\frac{1}{2}$*d*.
3. *£19*, 15*s*. $2\frac{3}{4}$*d*.
4. $\frac{2}{35}$
5. $-\frac{7}{144}$; $\frac{4}{15}$
6. ·05

1879.

1. 6 hours.
2. £449, 15*s.* 4·875*d.*; £50, 12*s.*
3. $\frac{24 \,.\, 20 \,.\, 33 \,.\, 14}{36}$; $5{\cdot}\dot{8}$; ·028
4. £7393, 0*s.* 5*d.*
5. £7, 0*s.* $7\frac{3}{4}$*d.*
6. ·866 foot.

1880.

1. A = £3267; B = £2662; C = £2057
2. £3, 0*s.* $11\frac{1}{12}$*d.*
3. £14, 17*s.* 1*d.* +
4. $5\frac{5}{11}$ hours.
5. $\frac{27}{10}$; $\frac{1}{60}$
6. 2663·215343; ·032
7. ·317

1881.

1. A walks 24 whilst C walks 25.
2. £227, 3*s.* $11\frac{5}{8}$*d.*; £157, 14*s.* $10\frac{1}{2}$*d.*
3. £23, 14*s.* $0\frac{1}{4}$*d.*
4. $\frac{54 \,.\, 75 \,.\, 16}{180}$; $\frac{7}{108}$
5. £150
6. 11·4 feet.
7. 3·605

V. Intermediate Education (Ireland) Examination Papers.

(Page 312.)

Junior Grade, 1879.

1. Three millions, nine hundred and five thousand, two hundred and eight.
2. 813—16
3. 3780
4. £48434, 0*s.* $4\frac{3}{4}$*d.*
5. £632, 19*s.* $6\frac{3}{4}$*d.*
6. £2601, 5*s.* $0\frac{1}{2}$*d.*
7. £3, 17*s.* $5\frac{1}{2}$*d.*
8. Divide the product by the multiplier and the quotient will be the multiplicand, or divide the product by the multiplicand and the quotient will be the multiplier.
9. ·181
10. £9794, 16*s.* 8*d.*
11. $3\frac{1}{8}$
12. $6\frac{6}{7}$ weeks.
13. £17, 12*s.* 6*d.*
14. The value becomes half the original value.
15. 21 men.
16. $1\frac{5}{8}$
17. Divide the product of the 2nd and 3rd terms by the 4th, and the quotient is the first term.

Middle Grade, 1879.

1. 30744
2. 3182079
3. 217800 sq. ft.
4. £11, 4*s.*
5. Multiply by 14 and divide the product by 11.
6. £57318, 0*s.* 2$\frac{3}{4}$*d.*
7. See Text, pp. 40, 41.
8. 9$\frac{29}{40}$
9. 1·45
10. £370, 12*s.* 10$\frac{1}{2}$*d.*
11. Divide their product by their G.C.M.
12. £57, 12*s.*
13. £978
14. 486
15. 6 days.
16. $\frac{2}{7}$ of 9*s.* 4*d.* is greater by 4*d.*
17. 79.

Junior Grade, 1880.

1. 6996 lbs. 6 oz. 6 dwts. 18 grs.
2. £407, 16*s.* 3*d.*
3. $\frac{1}{3}$
4. See Text and list of technical terms, pp. 42, 106.
5. £55, 4*s.*
6. 13
7. 21 men.
8. 10000
9. £74, 7*s.* 9$\frac{3}{4}$*d.*
10. £4068, 7*s.* 5·2*d.* +
11. See Text, p. 129.
12. 12 days.
13. 2 °/o
14. By dividing the antecedent by the consequent. See Algebra.
15. $\frac{5}{7}$

Middle Grade, 1880.

1. 1024 and MDLXIII remainder.
2. $\frac{132}{175}$
3. Nothing.
4. £81, 12*s.* 7$\frac{1}{14}$*d.*
5. £5, 6*s.* 8$\frac{1}{2}$ or $\frac{3}{4}$*d.*
6. Mercantile is greater by Interest on *true* discount for given period.
7. The latter.
8. 5$\frac{1}{3}$ days.
9. £4500
10. See Text, p. 128.
11. 1·638
12. 3$\frac{4}{5}$ years.
13. 2*s.* 6*d.* per lb.
14. £62, 15*s.* 1·056*d.*
15. 629

Senior Grade, 1880.

1. £48, 4*s.* 11$\frac{1}{4}$*d.*
2. 5 feet.
3. £2, 6*s.* 10*d.*
4. 8 feet deep.

Junior Grade, 1881.

1. 2303100762
2. £9, 17*s.* $1\frac{7}{25}$*d.*
3. 36 times; an abstract quantity.
4. $9756\frac{1}{4}$ oz.
5. Divide the product of the 2 means (or 2 extremes, whichever are given) by the other term.
6. $80\frac{10}{23}$ tons.
7. 5*s.*
8. 3960 men.
9. $514\frac{1}{2}$ days.
10. 8
11. $4\frac{11}{25}$
12. See Text, p. 121.
13. ·925
14. $1\frac{1}{2}$
15. £1839, 0*s.* $5\frac{5}{8}$*d.*
16. £719, 5*s.* $1\frac{1}{2}$*d.*
17. £70, 1*s.* $9\frac{1}{2}$·12*d.*
18. $5\frac{1}{2}$ %

Middle Grade, 1881.

1. 3373377225
2. 13 to 1
3. $\frac{16}{55}$
4. $1\cdot\dot{5}3544\dot{4}$
5. 2·646
6. £1701, 16*s.* 3*d.*
7. 4 weeks.
8. £5, 14*s.*
9. £12, 18*s.*
10. $42\frac{3}{16}$ galls.
11. 4037; 499
12. 1·322; $\cdot\dot{6}$
13. Wed. 20th July.
14. £995
15. 25 per cent.
16. £133, 6*s.* 8*d.*
17. £$\frac{6}{17}$
18. £190

Senior Grade, 1881.

1. 171 members.
2. £1, 1*s.* 11·365*d.*
3. £20 increase.
4. £3052, 4*s.*
5. 1·000005

Junior Grade, 1882.

1. £10,000
2. 1469995200
3. £120
4. 65520
5. £109, 4*s.*
6. 10 ft. high.
7. £4, 0*s.* 6*d.*
8. $6\frac{1}{2}$ days.
9. 2
10. 35
11. The first by $\frac{23}{150}$
12. $\frac{16825}{64125}$
13. £10149, 0*s.* $6\frac{2}{3}$*d.*
14. £56, 14*s.* $10\frac{4}{5}$*d.*
15. £42, 14*s.* $10\frac{11}{280}$*d.*

Middle Grade, 1882.

1. 90317
2. 3364 ac. 2 ro. 6 po.
3. $1\frac{2}{3}$
4. See Text, pp. 131, 132. 8.
5. £90, 8*s*. 9*d*.
6. £90
7. £131, 10*s*. 10*d*.
8. 40 hours.
9. 2662; 242
10. 52·82045
11. £76, 3*s*. 3*d*.
12. £62, 10*s*.
13. £500
14. $£952\frac{8}{21}$
15. £158, 17*s*. 6*d*.

Senior Grade, 1882.

1. $\frac{271}{1071}$
2. $\bar{2}$·58989
3. 1084785
4. ·3678794
5. $\sqrt{2}+1$; 2·4142

Junior Grade, 1883.

1. (*a*) Increases tenfold; nothing; (*b*) nothing; diminishes to one-tenth of original value.
2. 7440558706; 826636 + 8070; eight hundred and twenty-six thousand six hundred and thirty-six.
3. 26688
4. £43, 18*s*. $10\frac{1}{2}$*d*.
5. £511, 4*s*. 8*d*.
6. £77
7. 9*s*. $0\frac{1}{28}$*d*.
8. $22\frac{6}{7}$
9. $341\frac{29}{70}$
10. 2
11. $\frac{121}{480}$
12. 4*s*. $4\frac{2}{3}$*d*.
13. £24, 15*s*. 10*d*.
14. 324 yds.; £9, 18*s*.
15. $3\frac{1}{4}$

Middle Grade, 1883.

1. 21031
2. 960 men.
3. $5\frac{1}{4}$
4. $\frac{1105}{1824}$
5. £1, 3*s*. 1·875*d*.
6. £16, 7*s*. 1*d*.
7. ·063
8. 37028 is not an exact square, because the unit figure is 8, and the square of no digit gives 8 as unit figure; 5217400 is not an exact cube, as there must be three ciphers (or some multiple of three) instead of two, as in the number given.
9. 205·682.
10. $4\frac{1}{2}$ °/ₒ
11. £40
12. $86\frac{2}{3}$
13. £20 or £30, according as

£18 or £27 be considered the invested capital.

14. £120, 3*s*. $10\frac{2}{13}$*d*.; £162, 0*s*. $8\frac{8}{9}$*d*.
15. £858, 6*s*. 8*d*.

Senior Grade, 1883.

1. 453·07; 4530·72
2. 685700; ·011111 +
3. $132\frac{1}{2}$
4. £3575 or £3532·2

Junior Grade, 1884.

1. 21971
2. £5261, 16*s*. 3*d*.
3. £903, 15*s*. 9*d*.
4. See Text, p. 97.
5. £1812
6. $17\frac{3}{5}$ days.
7. £379, 12*s*. $3\frac{6}{7}$*d*.
8. The first receives £46, 17*s*.; the second, £15, 12*s*. 4*d*.; and the third, £3, 18*s*. 1*d*.
9. 3 oz. 7 dwts. $12\frac{10}{27}$ grs.
10. £10, 5*s*. 4*d*.
11. £1, 13*s*. $5\frac{1}{7}$*d*.
12. $87\frac{1}{2}$ or $\frac{175}{2}$
13. £1166, 10*s*. $3\frac{1}{3}$*d*.
14. £3, 18*s*. $4\frac{4}{5}$*d*. nearly.
15. £$352\frac{8}{11}$

Middle Grade, 1884.

1. See Text, p. 40. 84960
2. 8*s*. $10\frac{1}{2}$*d*.
3. 2·71828
4. £852, 18*s*. $5\frac{1}{4}$*d*.
5. $60675\frac{15}{29}$ gallons.
6. See Text, pp. 129, 130. $529\frac{17}{27}$.
7. ·001849
8. ·009
9. 31·3
10. 3*s*. $2\frac{1}{2}$*d*. +
11. £750
12. £4250
13. £$4621\frac{241}{779}$; £161, 14*s*. 11*d*. nearly.
14. No difference.
15. $9\frac{107}{477}$ %

Senior Grade, 1884.

1. £2030, 10*s*. 5*d*. nearly.
2. £580, 1*s*. $0\frac{194}{463}$*d*.
3. 2418025; 9873 t 1

Junior Grade, 1885

1. 396511
2. £199, 19*s*. 11*d*.
3. $70\frac{7}{8}$ yards.
4. 191808 c. in.
5. $3072\frac{3}{8}$
6. 18 men.
7. $643\frac{1}{2}$ miles.
8. £15, 10*s*.
9. 2
10. $\frac{619}{2000}$
11. $171\frac{1}{3}$ yds.; £3, 18*s*. $6\frac{1}{3}$*d*.
12. 9·5
13. £55, 19*s*. $4\frac{1}{2}$*d*.
14. £3376, 13*s*. 4*d*.
15. 4 %

Middle Grade, 1885.

1. 18396903; eighteen million, three hundred and ninety-six thousand nine hundred and three.
2. $4\frac{3}{8}$ days.
3. 1
4. $\frac{1}{21}$
5. £225
6. 63·12
7. 11 ft. 11 in.
8. 672
9. 2 years.
10. £1, 4*s*.
11. 1*s*. 6*d*.; £56, 18*s*.
12. £15 increase.
13. £7492, 10*s*.
14. £3607, 13*s*. $10\frac{2}{13}$*d*. or £$3607\frac{9}{13}$*
15. £591, 13*s*. 4*d*.

Senior Grade, 1885.

1. A's share = £156, 8*s*. 4·25*d*. +
   B's share = £360, 15*s*. 6·78*d*. +
   C's share = £278, 4*s*. 8·96*d*. +
2. £921, 8*s*. $5\frac{1}{2}$*d*. nearly.
3. $\frac{122103}{21224}$

*** If the value of the stock in the question were £3517, 16*s*. (and we imagine that this is intended by the Examiner), instead of £3517, 10*s*., the answer would be £3608, which is more in harmony with actual business transactions than an amount involving thirteenths of a pound sterling.**

THE END.

BOOKS FOR STUDENTS.

DESCHANEL'S NATURAL PHILOSOPHY. AN ELEMENTARY TREATISE. By Professor A. PRIVAT DESCHANEL, of Paris. Translated and Edited by J. D. EVERETT, M.A., D.C.L., F.R.S., Professor of Natural Philosophy in the Queen's College, Belfast. 8th Edition, revised throughout, and additions inserted, bringing it up to the present time. Illustrated by 783 Engravings on wood and 3 Coloured Plates. Medium 8vo, cloth, 18*s.*; also in Parts, limp cloth, 4*s.* 6*d.* each.

- Part I.—Mechanics, Hydrostatics, &c.
- Part II.—Heat.
- Part III.—Electricity, Magnetism.
- Part IV.—Sound and Light.

"Systematically arranged, clearly written, and admirably illustrated, it forms a model work for a class in experimental physics."—**Saturday Review.**

"We heartily welcome this sixth and greatly improved edition."—**Nature.**

"Deschanel's Treatise on Natural Philosophy has long been generally recognised as the best school manual of experimental physics in the language; the present edition makes it still better than it has ever been before."—**Pall Mall Gazette.**

COMMON THINGS AND ELEMENTARY SCIENCE, in the form of Object Lessons. By JOSEPH HASSELL, Associate of King's College, London. With 200 Illustrations and Diagrams. Sixth thousand, 384 pp., crown 8vo, cloth, 3*s.* 6*d.*

"This work indicates the nature of the school-book of the future. It will make the masters better teachers, and the pupils better learners. A more useful or more intelligent series of lessons than those described in this work it would be difficult to conceive."—**Dundee Advertiser.**

A MANUAL OF METHOD IN TEACHING. For Pupil-Teachers and Assistant Masters. Intended for Government Inspected Schools, and for the use of Students in Training Colleges. By A. PARK, F.R.G.S. Interleaved with ruled paper. Fourth edition, f'cap 8vo, cloth, 2*s.*

"We trace, throughout, the hand of an experienced teacher, adapting himself to the requirements of young persons, and giving them the results of long practice and observation. We can warmly recommend it to pupil-teachers, who will find it a great assistance not only as to the subjects they have to learn, but where help is most needed—in the subjects they have to teach."—**School Guardian.**

TEXT-BOOK OF DOMESTIC ECONOMY. Adapted to meet the requirements of Public Elementary Schools, Pupil-Teachers, Students in Training Colleges, and Candidates for Schoolmistresses' Certificates. By E. RICE, Lecturer on Domestic Economy at Cheltenham Training College. 232 pp., f'cap 8vo, cloth, 1*s.* 6*d.*

"A valuable text-book. Thorough knowledge of the subject and experience in methods of teaching are evident upon every page."—**School Board Chronicle.**

BOOKS FOR STUDENTS—*Continued.*

EXAMINATION ARITHMETIC; Containing 1200 Arithmetical Problems and Exercises (with Answers), selected from Oxford and Cambridge Local Examination Papers, &c. Classified by T. S. HARVEY, F.S.Sc.LOND. Cloth, 2*s.*

"We have no hesitation in saying that of all the examination arithmetics which have come under our notice this is by far the best. It reveals on almost every page the hand of the practised craftsman."—Practical Teacher.

KEY TO ABOVE. The Problems and Exercises fully worked out as they should be in an Examination Paper. Cloth, 4*s.* 6*d.*

ELEMENTARY MENSURATION, LINES, SURFACES, AND SOLIDS. With numerous Exercises. By JAMES MARTIN. F'cap 8vo, cloth, 10*d.*

"This book is clearly the work of one who knows how and what to teach beginners in this subject. The book will prove a sure foundation to a thorough knowledge of mensuration."—Teacher.

ELEMENTARY TEXT-BOOK OF TRIGONOMETRY. By R. H. PINKERTON, B.A.OXON., Late George A. Clark Fellow in Mathematics and Natural Philosophy in the University of Glasgow. 176 pp., foolscap 8vo, cloth, 2*s.* 6*d.*

This text-book will be found useful to students preparing for University Pass Examinations, and other Examinations in which Elementary Trigonometry is included.

ALGEBRA, UP TO AND INCLUDING EQUATIONS OF THE FIRST DEGREE. For Senior Pupils and Pupil-Teachers. By J. G. KERR, M.A. Cloth, 1*s.* 3*d.* KEY, 6*d.*

"Is to be recommended for its systematic arrangement, distinctness of explanation, and sufficiency of exemplification. Mr. Kerr gives useful directions and examples for writing down at sight the product of compound expressions, and the converse process of resolving products at sight into their component factors."—Athenæum.

ALGEBRAIC FACTORS: HOW TO FIND THEM AND HOW TO USE THEM. By W. T. KNIGHT, F.S.Sc.LOND. 1*s.* 6*d.*

"An intelligent study of this book will remove very many of those difficulties which puzzle the learner in simplification of fractions, involved equations, &c., and is a capital revision book to put into the hands of a lad who has already 'gone through' to the end of equations in the ordinary way."—Schoolmaster.

HISTORY OF THE BRITISH EMPIRE. By EDGAR SANDERSON, M.A., late Scholar of Clare College, Cambridge. With Illustrations, Genealogical Tables, Maps, and Plans. 441 pp., cloth, red edges, 2*s.* 6*d.*

"The narrative is wonderfully compacted with facts, and the facts are presented in the most systematic and orderly fashion; the student may find within the text, the textual arrangement, the marginal notes, the numbering of paragraphs, the dates and names in black type, the voluminous tables of dates, the genealogical trees, the maps, the minute index, and the like accessories, the machinery by which to qualify himself for examination, and for packing the knowledge in his mind in a shape available for all the purposes of precise historical information."—School Board Chronicle.

LONDON: BLACKIE & SON, 49 & 50 OLD BAILEY, E.C.;
GLASGOW, EDINBURGH, AND DUBLIN.